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Conseil Permanent International pour l'Exploration de la Mer

CHARLOTTENLUND SLOT — DANEMARK

ANNALES BIOLOGIQUES

VOLUME NO. XVIII

RÉDIGÉ PAR

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ANDR. FRED. HØST & FILS

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May 1963

Scheme for the Arrangement of the Material

I. Review of Investigations and Essential Results

Each Committee Chairman should here give a summary of the contributions received, i.e., a statement of the nature of the material as well as a short review of the position in the area—including the main results obtained—during the last calendar year (unless otherwise stated). This review should only in exceptional cases exceed 2 pages (about 10,000 units of type). Papers should reach the General Secretary not later than 1. May.

II. Tables and Conclusions

A. Environment

1. Strength and direction of currents: Especially data collected during spawning seasons.

2 a. Temperature and salinity conditions: Tables and/or diagrams including anomalies.

2 b. Seasonal temperature variations at selected stations: Data including anomalies.

3. Phosphate concentration, oxygen, etc.: Tables and diagrams to include anomalies.
4. Plankton conditions: Tables and/or diagrams, especially anomalies in distribution of indicator forms, phytoplankton patches, amount of plankton and fat content.
5. Abundance of benthonic food: Data.
6. The main meteorological features of the year: Data especially as to sunlight, rainfall, and direction and force of the wind.

B. The Fish

For each species in the following order: Gadoids (cod, haddock, saithe, others), flatfishes (plaice, dab, flounder, sole, witch, lemon sole, halibut, others), herring, sprat, mackerel, other pelagic fishes, eel, redfish, others.

1. Abundance and distribution of eggs and larvae.
2. Abundance of year-classes: Data derived from experimental hauls.
3. Size- and age-composition of commercial catches or landings.
4. Average length of age-groups: Data from experimental hauls and commercial catches, with standard deviations.
5. Rate of growth: Data from marking experiments and quantitative experimental hauls.
6. Rate of mortality: Data from marking experiments and quantitative experimental hauls.
7. Intensity of fishing: Data as to the fisheries considered in 3, 4, and 8.
8. Quantities landed:—
   (a) Total catch (weight) of special fisheries.
   (b) Percentage of large, medium, and small.
   (c) Total number of the various species.
   (d) Size- and age-composition of commercial catches or landings.

C. Shellfish

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SCHMIDT & KLAUNIG, KIEL

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PREFACE

Regarding the **hydrographical conditions,** it is interesting to note that the Atlantic inflow both off West Greenland (April/May) and East Greenland (August/September) was still stronger than in 1960 and that in July the highest temperatures during the last ten years were recorded at West Greenland. The ice conditions at the north-western corner of Iceland were normal but, in June, there was a strong inflow of Atlantic water along the north-west and north coasts, however, not as strong as in 1960. Generally, the Atlantic water was predominant in northern waters in 1961, indicated by comparatively high temperatures and salinities, the northernmost and eastern parts of the area excepted. An influx into the northern North Sea of abnormally cold water occurred in August resulting in relatively low surface temperatures in the North Minch. A strong inflow of North Sea water into the Baltic occurred in February/March, and it is likely that the bodies of water in the Gothland Deep were fully renewed late in the year.

The catches of **cod** on the West Greenland banks depended mainly on the 1947, 1953, 1957 and 1958 year-classes, but those of 1950 and 1956 appeared also in relatively good concentrations. The youngest year-classes, which were found at West Greenland, were almost absent from the catches taken off East Greenland. Here the catches were largely composed of the 1947, 1950, 1953 and 1956 year-classes. The Icelandic spawning stock was composed of a number of broods of which those of 1950, 1953 and 1955 were the strongest, whereas 4 and 5 year-old fish (1957 and 1956) were encountered outside the spawning area as immature individuals. In the Arcto-Norwegian stock (Norwegian coast), the 1954 and 1955 year-classes were predominant as far as can be seen from the rather scanty material, while the 1950 and 1953 classes were of medium strength. In the Baltic, 3, 4 and 5 year-old fish formed the greatest densities. Unfortunately there are no records from other sub-areas.

The volume contains records on **haddock** from all important areas. At Iceland there were substantial concentrations of 4 (NW, 48%) and 5 (SW, 67%) year-olds (1957 and 1956 year-classes). In the Barents Sea, the 1959 and 1957 year-classes were generally predominant and, off the Norwegian coast, 4 and 5 year-old fish were the most abundant. A fine Scottish survey of Faroe haddock reveals that the bulk of the landings was made up of 2—6 year-old fish. There were relatively fewer old fish and the yield per unit effort was unchanged compared with 1960. The records on North Sea haddock show that the 1958, 1959 and 1960 year-classes were moderate to good. The rich 1955 brood has now almost disappeared.

English and Scottish records on North Sea **whiting** indicate a good 1959 year-class and the same seems to apply to the 1960 brood, the distribution of which was more limited.

A new decline in the Norwegian winter **herring** yields was noted, making the catch poorer than in any other year since 1902. On the other hand, the Icelandic herring fishery showed a record of all times, as indicated in the introduction to the section on herring. The enormously developed tracing and fishing techniques of recent years have, however, contributed largely to the increase of the yields. The herring fishery of the southern North Sea was more productive than for many years, mainly owing to one, good year-class (1958). In the northern North Sea where the fishing principally was based on old fish (1956 year-class), the yields were poorer than in 1960. Important concentrations of young herring were reported in the western Kattegat, whereas small densities only were encountered in the German Bight and in Scottish, coastal waters.

Reference is made to some records on **redfish** (p. 80) and **halibut** (p. 81). A contribution on Danish **plaice** investigations, a detailed paper on Norwegian tagging of **dogfish,** and a report of the German **sand-eel** fisheries must also be mentioned. There are also several small contributions from the Baltic-Belt Seas area.

For further information concerning the fish stocks in 1961 reference is made to the *Statistical News Letters*, Nos. 14—16 and to the *Bulletin Statistique* for 1961.

Finally my best thanks are conveyed to all Chairmen and contributors to this volume and, last but not least, to Mrs. H. Harder of the Council's Publication Department, for her outstanding efforts in the preparation of this volume.

ÁRNI FRIÐRIKSSON

CHAIRMEN'S SUMMARIES OF AREA REPORTS

Distant Northern Seas

Contributions to this report have been received from:—

Denmark:
P. M. Hansen
F. Hermann

England:
J. Corlett

Germany:
G. Dietrich
G. Krefft

Iceland:
U. Stefánsson

Norway:
E. Bratberg

Scotland:
J. H. Fraser
G. T. D. Henderson
T. Lovegrove
A. D. McIntyre

U.S.S.R.:
A. P. Alekseje v
L. I. Borovaya
A. A. Degtyaryova
S. S. Drobicheva
B. V. Istoshin
A. G. Kislyakov
E. A. Pavshtiks
L. R. Shmarina

Hydrography

Norwegian investigations at the west coast of Greenland in April/May and at the east coast in August/September indicate a heavier inflow of warm Atlantic water in 1961 than in the two previous years. The drift ice off the West Greenland coast arrived unusually late.

Danish investigations in July at the west coast of Greenland show the highest temperatures in the last 10 years.

The ice conditions at the north-west coast of Iceland were normal. In June the temperatures in the uppermost 200—300 metres off the north and, especially, the north-west coast of Iceland were considerably higher than normal, but definitely lower than in 1960.

In the area between Iceland and Greenland a number of hydrographical stations were worked in connection with the German-Icelandic redfish survey of the area.

Soviet investigations in the Norwegian Sea and the Greenland Sea show that, compared with 1960, the year of 1961 was a very warm one, except in the northernmost part, where the temperatures were lower than normal. Soviet investigations also show that the temperatures on the Lofoten spawning grounds and in the inshore waters along the Norwegian and Murman coasts were lower than in 1960. In the western part of the Barents Sea temperature conditions were higher than normal and the years 1960 and 1961 were both characterized by unusually high salinity values in the whole area, caused by a strong inflow of Atlantic waters.

II. Plankton

Soviet investigations show that the biological spring in the Norwegian Shallows started somewhat earlier in 1961 than in 1960.

Compared with previous years, a peculiar feature in the Barents Sea was the absence of *Phaeocystis pouchetii* in April/May.

According to Soviet investigations, the average plankton biomass in June, in the feeding area near the boundaries of the East Icelandic Current, was somewhat lower than in previous years and, accordingly, the highest fat content of the herring was not reached until July.

The sampling with Plankton Recorders was continued from the Edinburgh Laboratory and was extended by the addition of a route between Liverpool and St. John's, Newfoundland, and also by a route from St. John's to Halifax, N.S., and from Halifax to Boston, Mass. Young stages of redfish were found in the areas south and south-west of Iceland, in the Irminger Sea and off Cape Farewell. They were all of the *S. marinus* type, and they occurred apparently a little later than in some of the previous years. The greatest numbers were found to the west of the centre line of the Reykjanes Ridge. The overall abundance was greater than in any other year sampled. The first records of the route between St. John's and Boston gave a small number of young redfish which were all of the *mentella* type.

The Aberdeen Laboratory reports on plankton investigations in the Faroe-Shetland region.

III. The Fish

English observations on the number and lengths of redfish larvae caught from Ocean Weather Station "A" in 1960 and 1961 is presented.

Danish trawling experiments for small redfish were continued in the Godthåb Fjord in 1961.

Eleven of the 251 redfish tagged there in 1960 were recaptured in 1961, most of them near to the marking locality, but one recapture on Fiskenæs Bank indicates that the stock of redfish in the Godthåb Fjord is not a local one.

The catch per unit effort in the Scottish halibut trawl fishery was lower than in 1960. The main fishing grounds are around the Faroe Islands and the bulk of the trawl landings are made up of two broods, with the modal lengths of 30 cm and 40 cm respectively.

A list of rare fishes caught in 1961 is given by Germany.

JÓN JÓNSSON

Near Northern Seas

Contributions to this report have been received from:—

Denmark:
AA. J. C. JENSEN
J. SMED
H. THOMSEN

Germany:
G. KREFFT
P. F. MEYER-WAARDEN

Norway:
O. AASEN

Scotland:
J. A. ADAMS
R. B. BURNS
J. M. COLEBROOK
R. E. CRAIG
J. H. FRASER
R. S. GLOVER
R. JOHNSTON
J. M. LAMONT
T. LOVEGROVE
B. B. RAE
G. A. ROBINSON
M. H. WILLIAMSON

Sweden:
A. SVANSSON

I. Hydrography

The largest contribution to this section is a continuation of the series of surveys of monthly and annual variations of the surface temperatures in different parts of the ICES area, which at intervals are given in *Annales Biologiques*. The main part of the North Sea has been divided in 5 areas and for each of these the monthly anomalies of the surface temperatures during 1902 to 1958 have been calculated on basis of the hydrographic card-index of the Council. This very useful information on the variation of an important environmental factor throughout half a century are tabulated and summarized in graphs. It appears that the distinct increase in the average temperatures, which took place in the 30'es was followed by a tendency towards lower temperatures in the late 40'es and 50'es.

As the hydrographical results of the international surveys, made under the auspices of the Herring Committee in 1961 will be published elsewhere, the contributions present no general outline of the hydrographic conditions in the North Sea in 1961. A Scottish survey of the northern North Sea in August suggests an intrusion southwards of quite abnormally cold water. According to Scottish thermograph data on the upper water temperatures in the North Minch in 1961, these were low compared with recent years.

Data from the eastern North Sea and Kattegat show no great deviations from the normal temperature and salinity conditions.

Observations on contents of oxygen and nutrient salts were made in the northern North Sea in March—April and September. The spring survey showed a lower level of phosphate compared with the preceding years, possibly resulting from the abnormally low oceanic incursions during the autumn of 1960.

II. Plankton

A considerable amount of information on the plankton conditions in the North Sea in 1961 is reported. Investigations from Aberdeen have been carried out in the north-western North Sea throughout the year and the continuous plankton recorder survey was continued on a similar scale to that of previous years but with extensions into the western Atlantic, thus covering all waters around the British Isles with monthly intervals. Furthermore the results of the standard plankton survey of the Buchan herring grounds during the summer months are presented.

The general picture is that the absence of a marked inflow of oceanic water in the autumn of 1960 left static conditions of low productivity in the north-western North Sea. In general, phytoplankton was more scarce than usual over the whole North Sea. Particularly noticeable was the resulting poor brood of *Calanus*. The scarcity of *Calanus* was distinct in the north-western North Sea in June. In July the area of scarcity had extended further southwards and eastwards and reached, in August, the south-eastern North Sea, where, during July, *Calanus* had been far more abundant than normally. A number of other copepods were scarce in the Atlantic and the northern North Sea but close to or above their average abundance in the German Bight. An

exception was *Acartia clausi* which showed the reverse of the geographical trend exhibited by *Calanus*, being abundant in the northern North Sea and below average in the German Bight.

III. The Fish

As usual, the contributions to this area report represent only fragments of the work on fishes carried out in the North Sea during the year. Important parts are reported under the special fish sections of this publication, and others will appear in "Statistical News Letters", "Cooperative Research Report" and elsewhere.

The Danish investigations on flatfish in the Skagerak-Kattegat area were continued. It was found that the density of 0-group plaice was about 3 times the normal in the northern and central Kattegat and that of the I-group below normal in the northern, but above normal in the central Kattegat. In the southern Kattegat, the density of both age-groups was very low. The commercial plaice fishery in Kattegat was in 1961 based on the rich year-classes of 1957, 1958 and 1959, and research vessel fishery in the northern Kattegat indicated a large stock of undersized plaice of the 1959 and 1960 year-classes.

The results of the Norwegian taggings of spiny dogfish in 1958—60 are reported. During this period nearly 6000 dogfish have been tagged in Shetland and Norwegian waters and, at the end of 1961, 442 or nearly 8% have been recovered. The analysis of the results indicate that, generally, there is a regular migration to the Norwegian coastal banks in the winter and back to the Hebrides-Shetland grounds in summer. Most of the recoveries of dogfish tagged in the Norwegian fjords were made not far from liberation localities, indicating that these fjord stocks are more stationary. An estimate of the recaptures shows a total yearly mortality rate of 0.25.

The continuation of the German sand-eel investigations showed a further decline in the German catch, which has fallen from over 25,000 tons in 1957 to about 4,500 tons in 1961.

Similar to 1959 the length composition of the dominant species *Ammodytes lancea marinus* showed a modal length of 15 cm while in 1960 the modal length was 11 cm. This increase of 4 cm might represent the average annual growth of the dominant year-class. As previously observed the amount of other species in the catches is extremely low.

List of recorded rare fishes have been received from Germany and Scotland.

E. Bertelsen

Baltic-Belt Seas

Contributions to this report have been received from:—

Denmark:
Aa. J. C. Jensen
Helge Thomsen

Germany:
R. Kändler
J. Krey

Poland:
W. Cieglewicz
A. Glowinska
A. Peczalska
Z. Reimann
Z. Ringer

Sweden:
A. Svansson

U.S.S.R.:
A. E. Antonov
G. B. Grauman
I. I. Nikolaev
S. O. Apiné
K. H. Krievs

I. Hydrography

The observations in the transition area and in the Baltic indicate that the winter of 1960/61 was rather mild and that the summer of 1961 was extremely wet. The maximum surface temperature in the eastern Baltic in August 1961 was only 17°C.

Helge Thomsen states that a strong inflow of North Sea water into the Baltic was observed in March. According to Glowinska this inflow took place earlier, due to the fact that in February already the salinity value of the near-bottom layer in Bornholm Deep was over 18‰. In Gothland Deep the intrusion of new water was observed by Svansson in July. According to Antonov, full renewal of the waters in Gothland Deep took place late in 1961. Krey presents the amount of the phosphorus components in Kiel Bay. In 1961 this amount was lower than the average for 1958—1960.

II. Plankton

The vertical and horizontal distribution of phytoplankton in the southern Baltic is described by Ringer. Nikolaev, Apiné and Krievs present quantitative characteristics of the zooplankton in the central Baltic and the Gulf of Riga. The zooplankton biomass was lower than usual during the winter season, in spring it was at the long-term average level and in summer above average. *Oithona similis* and *Sagitta elegans baltica* were

plentiful in Gothland Deep. Plankton concentrations, suitable for fish food, were on an average level in the autumn.

III. The Fish

The abundance of young flatfish in Danish coastal waters was investigated by JENSEN, by means of the Johansen young-plaice trawl. Relatively high numbers of 0- and I-group flounders were caught in the Sound, but in the Belts and the western Baltic the occurrence of these groups was very poor. In all areas the occurrence of 0-group plaice was lower than in the preceding year. Also I-group plaice were less numerous than in 1960, the Belts excepted.

Dr. KÄNDLER reports that, due to favourable water temperature in the mild winter of 1960/61 the spawning season in Kiel Bay seems to have been very good. The numbers of eggs of cod, flatfish and sprat were much higher than the average for 1954—60. The mean numbers of cod and flounder larvae per m^2 were also much higher than usual. The greater abundance of plaice eggs and the increased landings of plaice may be taken as a sign of the recovering of the stock in the western Baltic.

Unusually good catches of flatfish were made in 1961 by the Polish fishermen in the central and south-eastern Baltic. 2,157 tons were landed, in comparison with the average for the last 10 years amounting only to 1,150 tons. A relatively high number of flatfish fry was caught per hour with the hand-push net in the Polish coastal waters.

Due to the mild winter, the cod in the eastern Baltic spawned earlier, as observed by GRAUMAN. The average number of cod eggs per m^2 in Gdansk Bay was higher in 1961 than in 1960, but in the Gothland and Stolpen Deeps it was at the same level as in 1960. The survival of the cod eggs was also better than in previous years (see the Gadoid Fish section).

The results of lavaret investigations in the Pomeranian Bay are presented by PECZALSKA.

W. CIEGLEWICZ

PART I.

HYDROGRAPHY

A. Distant Northern Seas

Norwegian Investigations in Greenland Waters in 1961

(Figures 1–7)

West Greenland

The Norwegian R.V. "Johan Hjort" made a cruise to West Greenland waters in April/May 1961. Eight hydrographical sections were worked in the period 26. April to 8. May. The sections were situated between the following positions:—

	N	W	N	W
From Noname Bank and westward	61°41′,	49°40′—	61°13′,	53°10′
From Frederikshåb Bank westward	62°17′,	50°15′—	62°04,	52°08′
From Dana Bank and westward	62°50′,	50°48′—	62°16′,	54°04′
From Fiskenes Bank and westward	63°21′,	51°35′—	63°01′,	53°32′
From Fylla Bank and westward	63°58′,	52°30′—	63°28′	56°17′
From Banana Bank and westward	64°31′,	52°32′—	64°22′,	56°22′
From Sukkertoppen and westward	65°23′,	53°13′—	65°00′,	56°47′
From Søndre Strømfjord and westward	66°05′,	54°06′—	65°56′,	55°45′

Figures 1—4 show the isotherms in four of the sections.

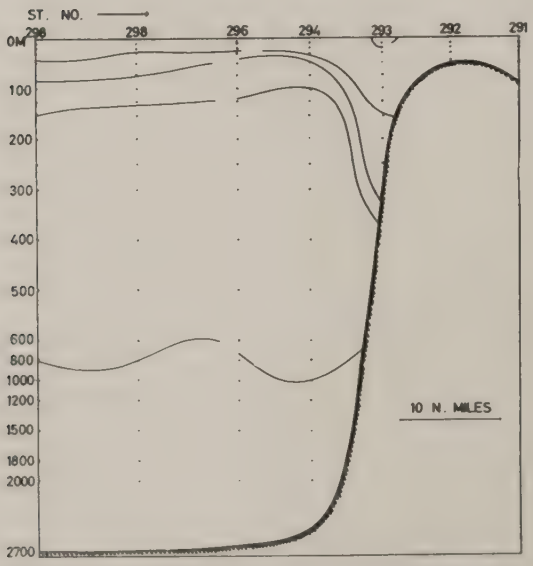


Figure 1. "Johan Hjort", West Greenland, April/May 1961. Temperature section from Noname Bank and westward.

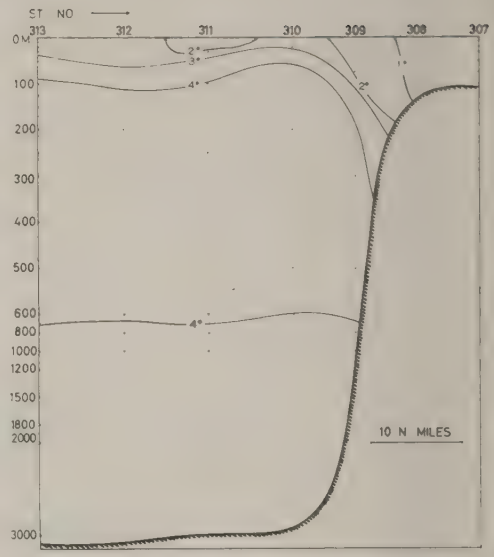


Figure 2. "Johan Hjort", West Greenland, April/May 1961. Temperature section from Dana Bank and westward.

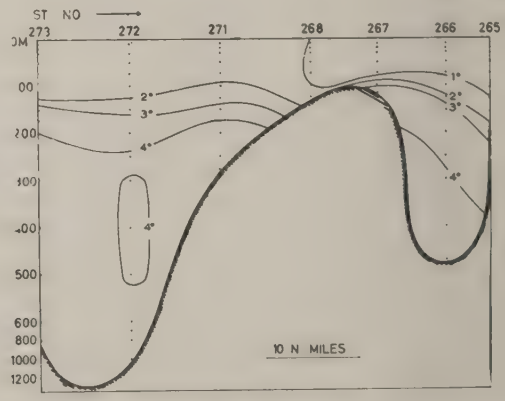


Figure 3. "Johan Hjort", West Greenland, April/May 1961. Temperature section from Banana Bank and westward.

The temperatures did not indicate any unusual change in the West Greenland Current. As usual cold water of Arctic origin with temperatures below 2°C covered the tops of the banks, while mixed water of mostly Atlantic origin characterized the water masses on the western slopes below. However, compared with the hydrographical situation at

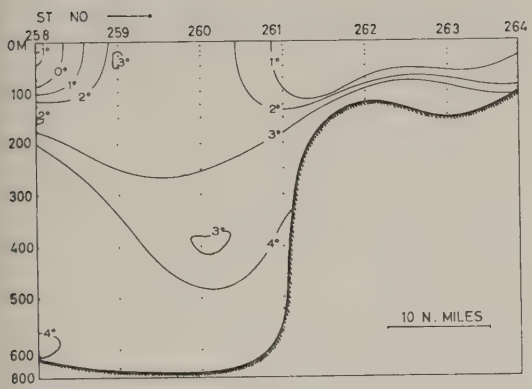


Figure 4. "Johan Hjort", West Greenland, April/May 1961. Temperature section from Sukkertoppen and westward.

approximately the same time in 1959 and 1960 the temperatures seemed to be somewhat higher in the surface layers in 1961. The comparatively high temperatures in the surface layers may have been due to stirring caused by the wind, but the favourable ice conditions may also have been an influencing factor.

The drift ice arrived unusually late. The Nanortalik Bank and the waters off Julianehåb, which are usually covered with ice from early March, were generally open. Drift ice was not encountered until the northernmost station on the cruise was reached. Heavy pack ice was met with off Søndre Strømfjord in position 66°05′ N, 56°05′ W.

The high temperatures in the surface layers may, on the other hand, have been caused in part by a heavier inflow of warm water of Atlantic origin in 1961 than at the same time in 1959 and 1960.

East Greenland

Between 24. August and 5. September, 3 hydrographical sections were worked in East Greenland waters. Temperature registrations by means of a bathythermograph were made in 17 other localities. The sections were situated between the following positions:—

	N	W	N	W
From Prins Christian Sund and eastward	60°04′,	42°55′—	60°03′,	40°54
From Kunerinak and eastward	61°24′,	42°06′—	61°24′,	40°43′
From Cape Dan and south-eastward	65°20′,	36°32′—	64°32′,	34°25′

The isotherms in the sections are shown in Figures 5—7.

Compared with 1959 the water seemed to be warmer in 1961, especially in the Arctic component of the East Greenland Current. Only at Cape Dan

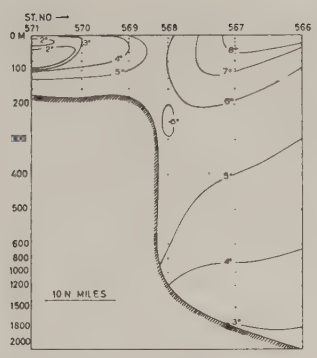


Figure 5. "Johan Hjort", East Greenland, August/September 1961. Temperature section from Prins Christian Sund and eastward.

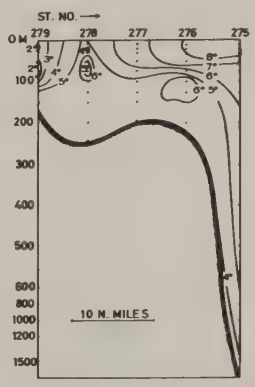


Figure 6. "Johan Hjort", East Greenland, August/September 1961. Temperature section from Kunerinak (Cape Tordenskjold) and eastward.

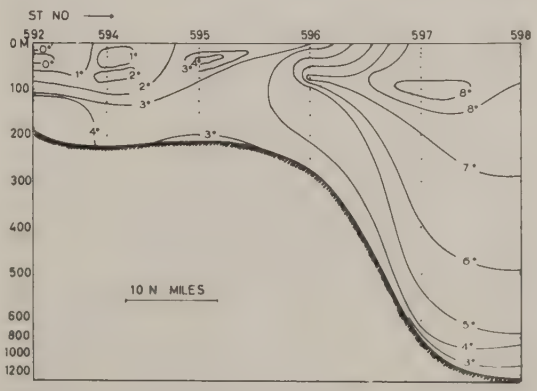


Figure 7. "Johan Hjort", East Greenland, August/September 1961. Temperature section from Cape Dan and south-eastward.

temperatures below 1°C were recorded. The Arctic component of the current did not seem to be as heavy as in 1959. The comparatively warmer temperatures may to some degree be due to the very favourable ice conditions at that time. Between Cape Farewell and Cape Dan there was no drift ice before the 5. September. At that time drift ice came from the north-east and into the area off Cape Dan. In addition, the warmer temperatures must in part have been caused by a stronger influx of Atlantic water from the Irminger Current.

ERLING BRATBERG

Hydrographic Conditions off West Greenland, 1961

(Figures 8–13)

In 1961 the M/C "Adolf Jensen" worked the Fylla Bank section in April and June. R.V. "Dana" worked the sections over Fylla Bank, Lille Hellefiske Bank, Store Hellefiske Bank, and off Egedesminde

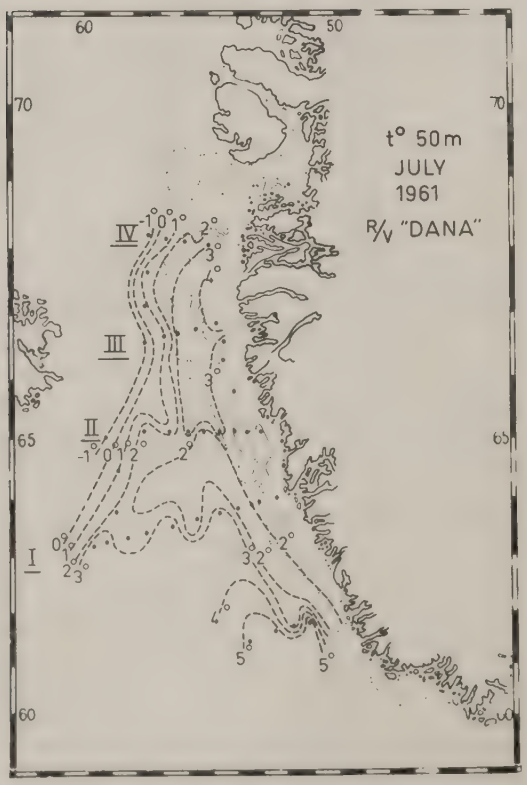


Figure 8. Location of stations and distribution of temperature at 50 m, July 1961.

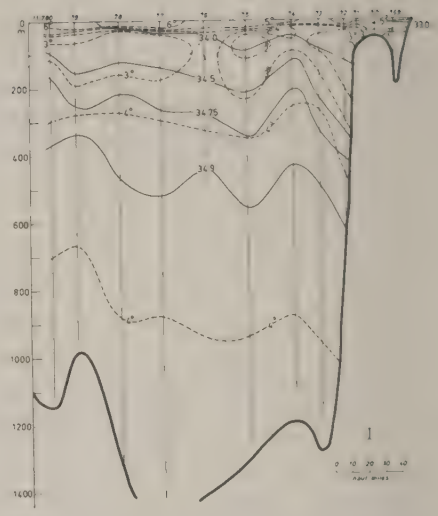


Figure 9. Section I across Fylla Bank, 24. to 26. July 1961 (the two westernmost stations not shown).

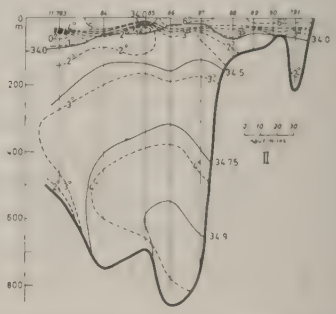


Figure 10. Section II across Lille Hellefiske Bank, 27. to 28. July 1961.

Figure 11. Section III across Store Hellefiske Bank, 29. July 1961.

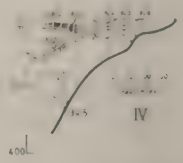


Figure 12. Section IV off Egedesminde, 30. July 1961.

in July. The positions of the "Dana" stations are shown in Figure 8. Moreover, the standard station at the entrance to Godthåb Fjord was worked throughout the year by M/C "Adolf Jensen" and "Tornaq".

Figure 8 shows the distribution of temperature at 50 m in July. A comparison with earlier years' observations shows that the temperature all over the area was considerably higher than usual. Of the last 10 years, only the year 1960 shows water temperatures almost as high as those found in the surface layers in July 1961.

Over the shallow part of Fylla Bank (40 m) the temperature on 24. April was 0.5°C, on 27. June 3.1°C, and on 24. July it was 3.9°C. The hydrographic situation in July is further illustrated by the sections I to IV (Figs. 9—12). The sections show that the minimum temperature in the polar component of the West Greenland Current, found off the western slope of the banks in sections I and II, was higher than usual. The Irminger component of this current was well developed.

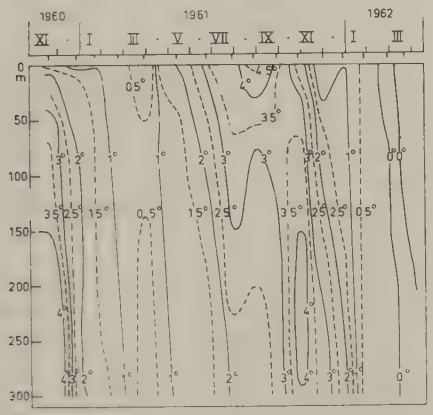


Figure 13. Distribution of temperature at the entrance to Godthåb Fjord during 1961.

The variation of the temperature throughout the year at the station at the entrance to Godthåb Fjord (64°07'N, 51°53'W) is shown in Figure 13. Also here relatively high temperatures prevailed. No sub-zero temperatures were observed and a strong inflow of warm bottom water seems to have taken place in October/November. In the first months of 1962 a strong cooling of the water occurred and sub-zero bottom temperatures were recorded in March 1962.

FREDE HERMANN

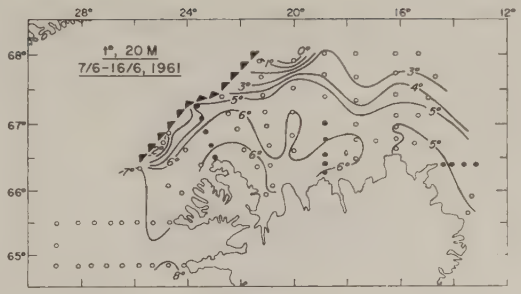


Figure 14.

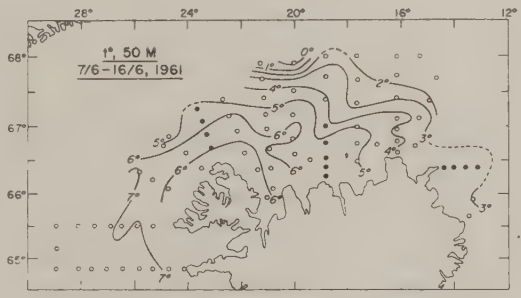


Figure 15.

Hydrographic Conditions in North Icelandic Waters in June 1961

(Figures 14—19)

A hydro-biological survey was carried out in the waters north-west and north of Iceland from 7. to 16. June. Figures 14—16 show the location of the stations worked and the distribution of temperature at 20 m, 50 m, and 100 m. The temperature data consisted of BT observations except for three hydrographic sections, north-north-west of Kögur, north of Siglunes and east of Langanes (see Fig. 14).

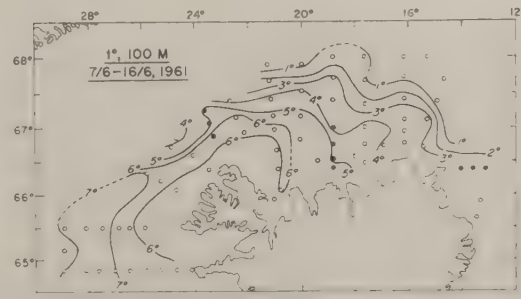


Figure 16.

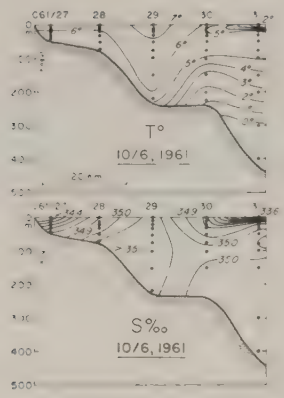


Figure 17.

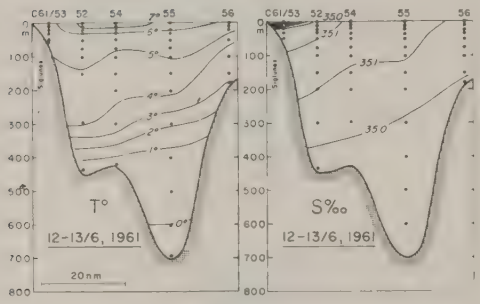


Figure 18.

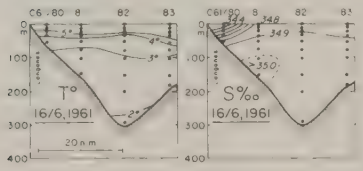


Figure 19.

The ice conditions off the north-west coast were about normal. The shortest distance from Cape Kögur to the ice border was 50—60 miles.

At 20 m the temperature in most part of the area was about 0.5°C higher than the 1950—1960 mean. At 50 m it was 0.5—1°C above normal off the north-west coast, about 1° above normal on the north Icelandic grounds, and about 0.5° higher than normal off the north-east coast. At 100 m it was 0.5—1°C higher than normal off the north-west and north coasts, but about normal off the north-east coast.

The sections off Kögur, Siglunes and Langanes indicate that the relatively high temperature and strong Atlantic influence also prevailed in the intermediate layers, between 100 and 300 metres. In all sections remarkably high salinities were observed. In the section off Kögur the conditions were similar to those found in June 1954, which was an unusually warm year. Off Siglunes the salinities were similar to those found in the exceptionally warm year of 1960, but the temperatures were somewhat lower. In the section off Langanes, however, the temperatures were similar to or only slightly higher than normal.

On the whole, it may thus be concluded that in June 1961 the temperatures of the uppermost 200—300 metres were considerably above normal, especially in the western part of the area, but definitely lower than in 1960.

UNNSTEINN STEFÁNSSON

Hydrographic Conditions in the Northern North Atlantic in April/May 1961

(Figures 20—29)

The investigations of the spawning areas of redfish and the distribution of redfish larvae, which were made jointly by the Icelandic coastguard vessel "Ægir" and the German research vessel "Anton Dohrn" in April/May 1961 included a quasisynoptic survey of the hydrographical conditions. The area investigated reached from 50°N to 67°N and 10°W to 42°W.

The hydrographical measurements were confined to the distribution of temperature and salinity from the surface down to 500 m. 86 hydrographic stations and 87 BT stations were worked by "Ægir", 99 and 47 respectively by 'Anton Dohrn".

These observations are illustrated in Figures 20 to 29. Figures 20—27 show the distribution of temperature and salinity at 20, 50, 100, and 200 metres, Figures 28 and 29 a vertical section extending west-east along the 54°40′N parallel from 42°W to 29°W. The ice border is indicated on Figures 20 and 24. The width of the drift ice belt along the east coast of Greenland was found to be distinctly less than normal as compared with the mean ice limit for April/May in the period 1919—1943[1]).

[1]) BÜDEL, J., 1950. "Atlas der Eisverhältnisse des Nordatlantischen Ozeans." Deutsches Hydrographisches Institut. Hamburg.

Figure 20. Temperature distribution (°C) at 20 m in April/May 1961.

Figure 21. Temperature distribution (°C) at 50 m in April/May 1961.

Figure 22. Temperature distribution (°C) at 100 m in April/May 1961.

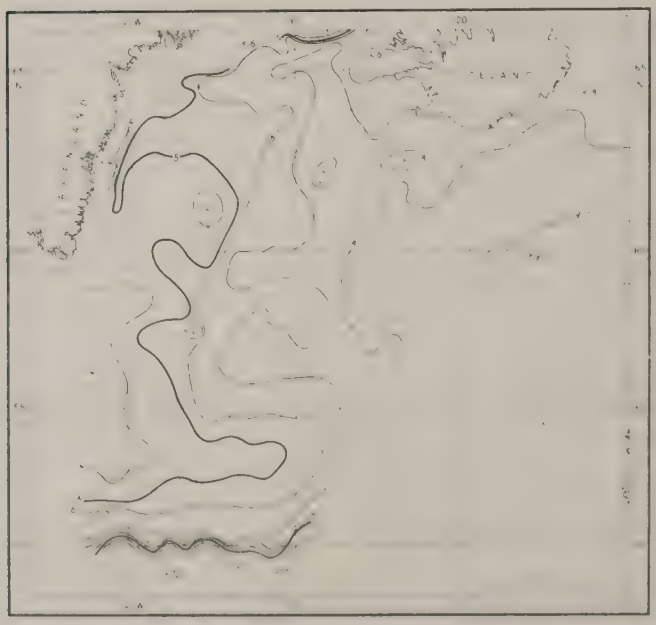


Figure 23. Temperature distribution (°C) at 200 m in April/May 1961.

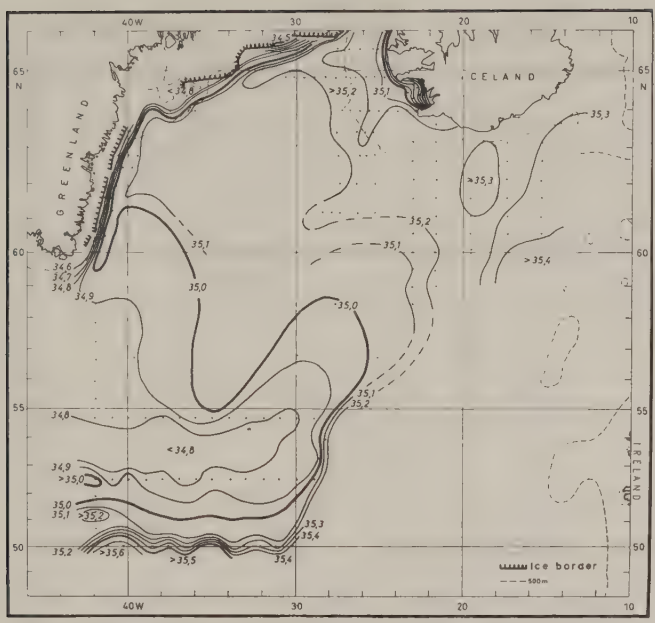


Figure 24. Salinity distribution at 20 m in April/May 1961.

Figure 25. Salinity distribution at 50 m in April/May 1961.

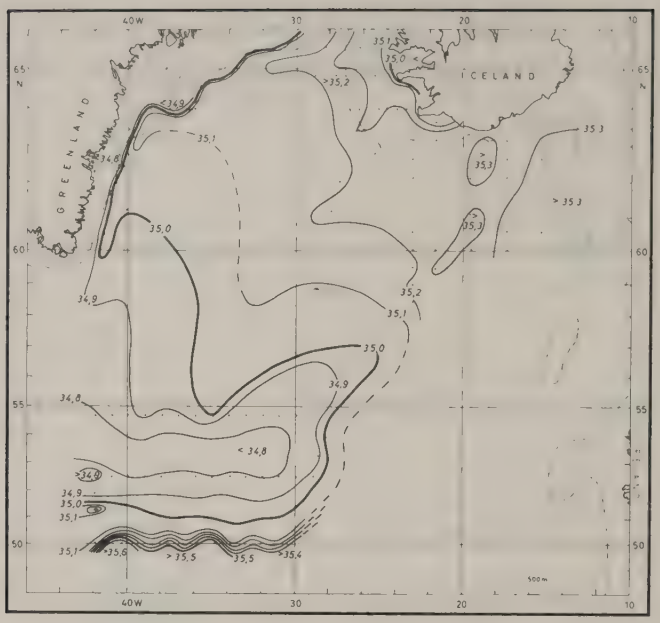
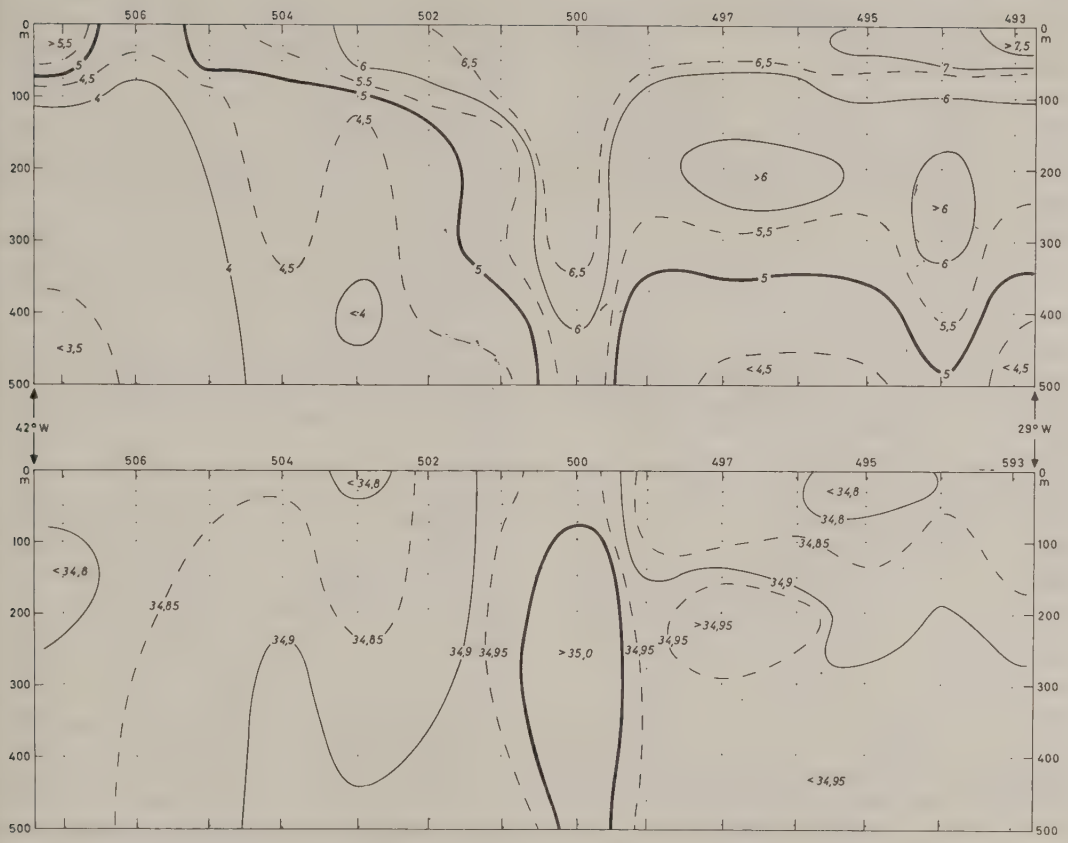


Figure 26. Salinity distribution at 100 m in April/May 1961.

Figure 27. Salinity distribution at 200 m in April/May 1961.



Figures 28 and 29. Section of temperature (°C) and salinity (‰) along 54°40′N from 42°W to 29°W.

The narrow band of the North Atlantic Current is clearly evident at 50°N. At 29°W it bends towards NE, and north of 55°N it splits. From the surface down to 200 m the right flank of the current contains warm water with high salinity (> 12°C, > 35.6‰). On the left, cold water with lower salinity (4—6°C, < 34.8‰) runs out of the Labrador Sea. These two water bodies of different origin were included in a large eddy, the centre of which lies at about 55°N, 32°W. A second core of a cyclonic eddy, distinguished by its low temperatures, lies at 61°N and 38°W. West of Iceland along the edge of the shelf a narrow tongue with relatively warm and saline water extends northwards. At 65°N it splits in two, one part continuing northwards along the Icelandic shelf, the other part leading into the narrow band of the East Greenland Current, where the isolines come close together near the ice limit.

As far as the authors know, the first mentioned large eddy has not been observed before. It might be important for the distribution of redfish larvae. It is also apparent in the vertical section (Figs. 28 and 29). Station 500 is approximately situated at the core. West of station 500, relatively warm water of higher salinity is transported towards the south.

G. Dietrich, U. Stefánsson

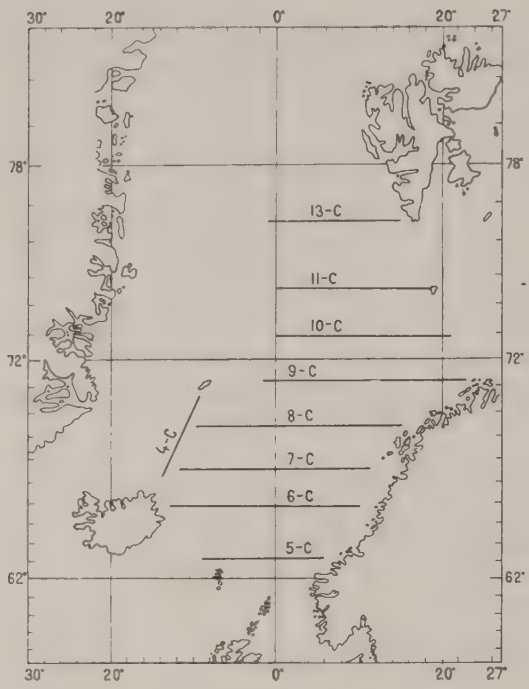


Figure 30. Sections worked in June, 1961.

Soviet Hydrological Investigations in the Norwegian and Greenland Seas in 1961

(Figures 30–33)

In order to estimate the heat content of the waters of the Norwegian and Greenland Seas during 1961, the data from the oceanographic survey conducted during the period 8. to 28. June by the research and scouting vessels "Tunetz", "Professor Mesyatsev", "Academician Berg", "Argun", and "Zvezda" were used. The investigations covered the area from 63°N in south to 76°30′N in north (Fig. 30). Data for the sections worked during other months in 1961 have also been used.

In 1959/60 the hydrological conditions in the Norwegian Sea were characterized by a rather strong inflow of warm Atlantic water. This process was in progress until spring 1961. The decrease in heat transport by the current, started in spring 1961, caused a fall in the temperature in the water layer extending from the surface to 500 m depth on the sections along 63°N and 65°45′N. By June 1961, in the central areas of the Norwegian Sea, a "heat reserve" was, however, still available. For instance, on the sections along 67°30′N and 69°20′N the water temperature was even higher than in the warm year of 1960. It was, probably, furthered by favourable meteorological conditions. However, while moving northwards from the section along 71°10′N, the high heat content of the water is rapidly decreasing, and already on the sections along 72°50′N and 74°30′N (the western branch excepted) an abrupt fall in temperature in all layers is observed, compared with 1960.

Figure 31 gives an idea of the thermal conditions in the Norwegian and Greenland Seas in 1961, showing temperature deviations from normal for the period 1957/1961 on all the sections in the branches of the Norwegian Current.

*The Eastern Branch**). On the southern sections of the eastern branch of the Norwegian Current the temperature was about normal and a little lower than in 1960. On the sections along 67°30′N and 62°20′N the temperature of all the water layers down to 500 m increased by 0.3° to 0.5°C in comparison with 1960 and approximately by 1°C with respect to the normal temperature. On the section along 71°10′N a certain decrease was again observed, although it was still 0.3° to 0.5°C over normal. Further north, on the sections along 72°50′N and 74°30′N the temperatures of this branch decreased in all water layers by 0.4° to 0.7°C, being 0.2°—0.4°C below normal.

The Middle Branch. On the section along 69°20′N the mean temperature in the 0—200 m layer was 0.3°C higher than in 1960. In the same layer on the section along 71°10′N a decrease of 0.2°C was observed. Maximum decreases were observed in all the layers on the section along 72°50′N and 74°30′N where the temperature appeared to be 0.6° to 0.8°C below normal.

The Western Branch. The greatest irregularity of temperature distribution was recorded in the waters of the western branch. On the section along 65°45′N and 71°10′N in all layers, the temperature remained at the normal level, having dropped 0.5°—0.8°C in comparison with 1960. On the section along 67°30′N and 69°20′N in the 0—200 m layer a temperature rise of 0.5°C took place. In the deep layers the deviations from normal were insignificant. While in 1960, on the section along 72°50′N, temperature anomalies were oscillating between + 0.3° and + 0.4°C, being about normal in all layers on the section along 74°30′N then in 1961 they were + 0.5°, + 0.8°C and + 1.1°C respectively.

*) A diagram of the currents is shown in a paper by Aleksejev and Istoshin, 1956: Trudy PINRO, 9.

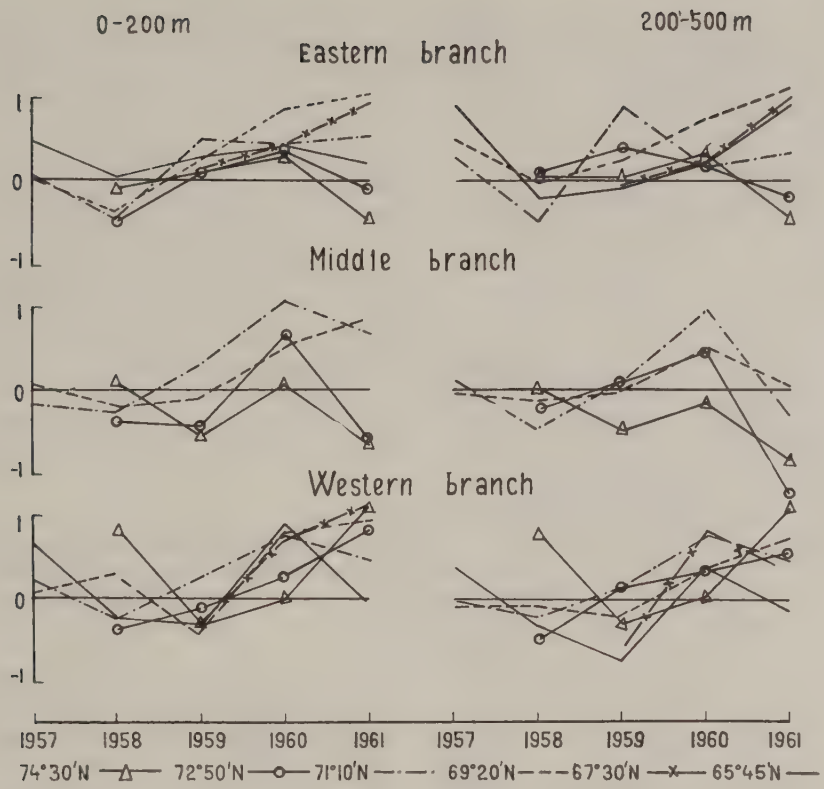


Figure 31. Water temperature deviation from normal in the eastern, middle and western branches of the Norwegian Current on standard sections during 1957—1961.

For the estimation of the thermal conditions in the waters of the East Icelandic Current, data were used from the section Langanes Cape/Jan Mayen and the western parts of the southern sections of the Norwegian Sea.

The waters of the East Icelandic Current on the section along 65°45′N appeared to be 0.7°C and 0.2°C colder respectively in the 0—50 m and the 0—200 m layer than in 1960. In the deep layers the temperature remained at the level of the preceding year. Along 67°30′N the temperature in all the layers was approximately 0.5°—1.0°C higher than in 1960. On the section between Langanes Cape and Jan Mayen the temperature of the East Icelandic Current in the 0—50 m layer was 0.2°C lower than in 1960. In other layers it remained at the level of 1960 and at the normal level (Fig. 32).

In the southern part of the Norwegian Shallows the average water temperature was 0.1°C lower than in 1960. To the north (the section along 67°30′N), the temperature in the 0—50 m layer

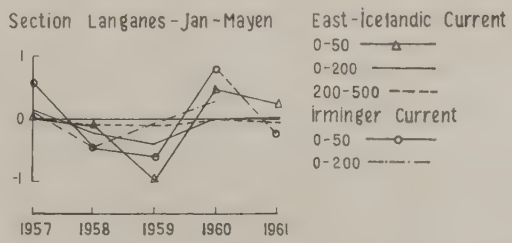


Figure 32. Temperature deviation from normal in the waters of the East Icelandic Current on the section between the Langanes Cape and Jan Mayen during 1957—1961.

was 0.4°C and in the 0—200 m layer 0.1°C higher than in 1960. Off the Norwegian coast lower temperatures were recorded, differing about 1°C from those of 1960.

Individual observations on the sections worked during other months of 1961 corroborate the data obtained in June as to the characteristics of the

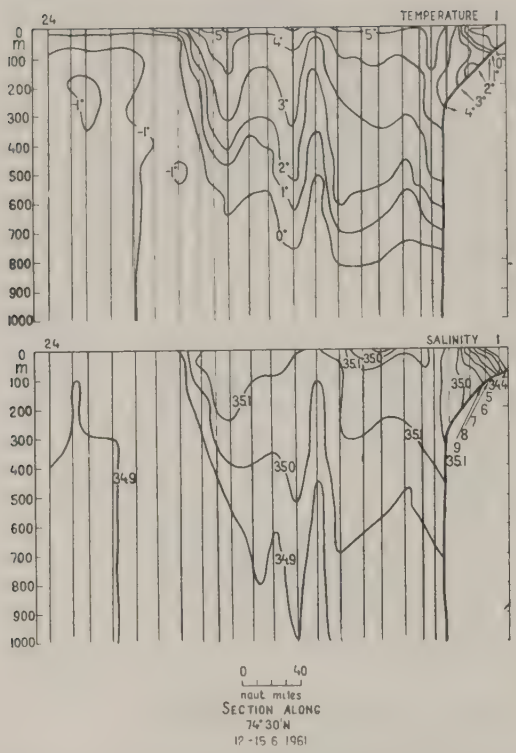


Figure 33. Temperature and salinity distribution on the section along 74°30′N to the west of Bear Island.

heat level of the Norwegian Current. For example, on the section along 65°45′N in the 0—50 m and 0—200 m layers of the eastern branch, the mean April/June temperatures remained at the level of the warm year of 1960. Along 67°30′N the mean temperatures in the same layers were at the level of 1960 and a little higher throughout the year.

In April, June, September, and November the mean temperatures of the East Icelandic Current along 65°45′N were somewhat lower in the 0—50 m layer than those of 1960, while they were at the same level of that year in the 0—200 m layer. At the end of September/beginning of October, on the section along 69°20′N, the temperatures of the Norwegian Current in both these layers remained at the level of 1960. For the section along 71°10′N comparison is only possible for April, June, and August. In April the average temperature of the waters of the eastern branch and along the whole section in the 0—50 m and the 0—200 m layers was between 0.2° and 0.3°C lower than in 1960. In August the mean temperatures in these two layers increased somewhat compared with 1959 and, evidently, reached the level of 1960.

Figure 33 illustrates the temperature and salinity distribution of the section along 74°30′N westwards of Bear Island.

While examining the thermal conditions in the Norwegian and Greenland Seas in 1961 they were compared with those of 1960, a very warm year for this area. It is concluded that in the south of the Norwegian Sea the rate of heat inflow from the Atlantic has decreased. In the major part of the Norwegian Sea the year 1961 was warm. On the section along 63°N it was about normal. On the northern sections along 72°50′N and 74°30′N it was a cold year.

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L. R. Shmarina

Hydrological Conditions in the North-Eastern Part of the Norwegian Sea and the Adjacent Area, April/July 1961

(Figures 34–36; Tables 1–2)

As in previous years, two special cruises (Fig. 34a) aiming at investigating the Lofoten spawning grounds were undertaken with the Soviet R.V. "Tunetz" during the periods 18. April to 21. May and 1. June to 6. July 1961.

In winter, especially in March/April, the temperature of the waters along the Norwegian coast is considerably lower than that of the Atlantic waters due to the different depth of convective intermixing. Off the coast, in the area extending from Røst to Fugløy the temperature of the surface water was 4.5°—5.0°C at the end of April/beginning of May. In the area from 67°30′N to 74°00′N the temperature of the Atlantic waters of the eastern branch of the Norwegian Current was 7.2°—5.0°C in the first half of May. In the south-western part of the Barents Sea the temperature of the North Cape Current was 4°—5°C during the second half of May. Within the coastal zone the highest temperature was observed in the area between Fugløy and the northern extremity of Sørøya. In the North Cape Current there is no such temperature contrast between the coastal zone and the open sea, as between the coastal and the Atlantic waters in the Norwegian Sea. Investigation of this area in the period June/beginning of July showed that the water temperature at the surface (Fig. 34c) increased up to 8.8°C in the coastal waters, 9.5°—9.8°C in the Atlantic waters, and 7°—8°C in the North Cape

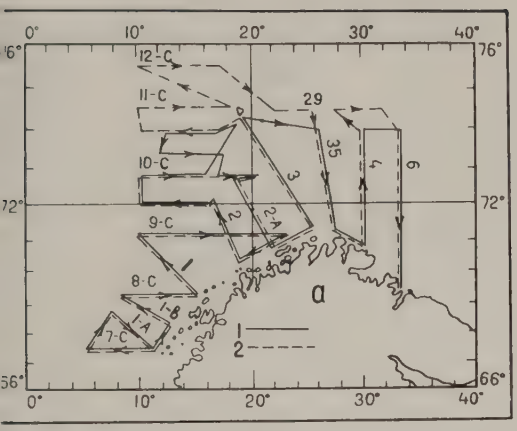

Figure 34a. Chart of the routes of the R.V. "Tunetz". 1: 18. April to 21. May 1961; 2: 3. June to 6. July 1961.

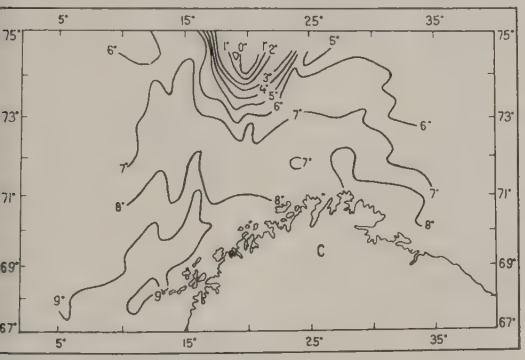

Figure 34c. Surface temperature, 3. June to 6. July 1961.

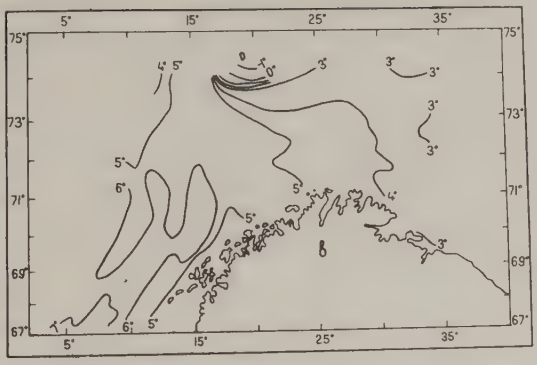

Figure 34b. Surface temperature, 18. April to 21. May 1961

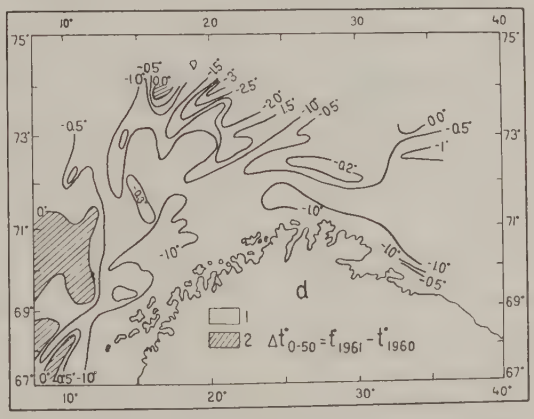

Figure 34d. Isallotherm chart for the 0—50 m layer. 1: Areas where in April/May 1961 the temperature was lower than in 1960. 2: Areas with higher temperatures than in 1960.

Current; the temperature in the Finnmark and Ribachy areas was even over 8°C.

It is evident from the chart of isallotherms (Fig. 34d) that in the area of the Lofoten spawning grounds and in the inshore waters extending from North Cape to Kola Bay the temperature in the upper 50 m in 1961 was between 1.0° and 1.5°C lower than in the same period of 1960. Over the remainder of the area examined, the two regions in the eastern branch of the Norwegian Current excepted, the temperature was also lower than in 1960, especially in the area adjoining the southern slope of Bear Island. The rate of temperature decrease was different as interchange of regions with higher and lower temperatures was observed.

For estimation of the heat level of 1961, in comparison with the two previous years, mean temperatures were calculated for the 0—200 m layer within certain limits on all the sections worked from the R.V. "Tunetz" during April/May of 1959, 1960, and 1961 (Table 1).

Mean temperature changes from year to year in the sections are shown in Table 2, from which it is clear that from 1959 to 1960 an increase took place, while from 1960 to 1961 a decrease of the temperature was observed.

Thus, the warmest of these three years is 1960, 1959 being less warm, and 1961 even colder than 1959. However, as is evident from Table 2, temperature changes in different sections are not only different as to their absolute value, but in several instances even have opposite values. It is quite obvious (Fig. 35) that an interchange of increased and decreased temperature deviations takes place which indicates a turbidity of the current with periods of about half a month and one month,

Table 1. Mean temperature (°C) of the 0—200 m layer in standard sections in 1959, 1960, 1961

No. of Section	Positions N	Positions E	Positions N	Positions E	1959 Date of observation	1959 Mean temperature	1960 Date of observation	1960 Mean temperature	1961 Date of observation	1961 Mean temperature
7—C	67°30′	05°00′	—67°30′	08°30′	24.–25. Apr.	6.38	27.–28. Apr.	7.12	24.–25. Apr.	6.79
8—C	69°20′	11°00′	—69°20′	14°45′	29.–30. Apr.	6.20	2. May	6.27	28.–29. Apr.	6.44
9—C	71°10′	12°00′	—71°10′	14°50′	3. May	6.34	5. May	6.26	30. Apr.–1. May	5.95
—	72°00′	11°30′	—72°00′	15°30′	10. May	5.44	10.–11. May	5.92	4.–5. May	5.31
10—C	72°50′	11°30′	—72°50′	15°00′	12. May	5.62	11.–12. May	5.63	5.–6. May	4.99
—	73°50′	13°30′	—73°50′	16°30′	—	—	17.–18. May	5.30	9. May	4.93
1—A	68°00′	10°00′	—68°50′	07°30′	26.–27. Apr.	6.61	29. Apr.	6.31	26. Apr.	6.55
1—B	68°36′	12°05′	—69°05′	09°30′	28. Apr.	6.87	30. Apr.–1. May	6.45	27. Apr.	6.05
1	69°30′	15°36′	—70°06′	13°40′	1. May	6.15	3.–4. May	6.96	29. Apr.	6.01
2	70°24′	19°04′	—72°10′	16°20′	5.–6. May	6.10	8.–10. May	6.34	3.–4. May	5.81
2—A	70°48′	21°46′	—72°40′	18°40′	13.–14. May	5.63	13.–14. May	6.10	11.–12. May	5.54
3	71°33′	25°02′	—73°35′	20°46′	17.–18. May	4.82	15.–16. May	5.03	12.–13. May	4.60
35	71°36′	27°27′	—73°07′	26°28′	19.–20. May	4.43	20.–21. May	4.58	14.–15. May	4.27
4	71°30′	30°00′	—73°00′	30°00′	21. May	4.16	22. May	4.32	18. May	3.85
6	70°30′	33°30′	—72°30′	33°30′	22.–23. May	3.59	23.–24. May	3.84	20. May	2.96

Table 2. Deviations of the mean temperature in the 0—200 m layer of the different sections

Sections	Temperature fluctuations from 1959 to 1960	Temperature fluctuations from 1960 to 1961	Temperature fluctuations from 1959 to 1961
7—C	+0.74	−0.33	+0.41
1—A	−0.30	+0.24	−0.06
1	−0.42	−0.40	−0.82
8 C	+0.07	+0.17	+0.24
1	+0.75	−0.70	−0.14
9—C	−0.08	−0.31	−0.39
Along 72°N ..	+0.48	−0.61	−0.13
10 C	+0.01	−0.64	−0.63
Along 73°50′N	—	−0.37	—
2 A	+0.24	−0.53	−0.29
2	+0.47	−0.56	−0.09
3	+0.21	−0.43	−0.22
35	+0.15	−0.31	−0.16
4	+0.16	−0.47	−0.31
6	+0.25	−0.88	−0.63

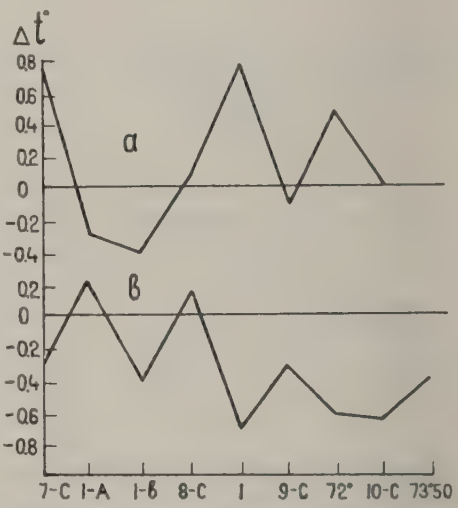

Figure 35. Mean temperature differences of the 0—200 m layer in different sections in April/May. a = fluctuations during 1959/1960. b = fluctuations during 1960/1961.

assessed from the distance between maximum temperature values and the velocity of the water transport in this area.

In the spring of 1961, the salinity of the Atlantic waters was several hundredths of a per mille lower than in 1960, the isohaline of 35.20‰ being respectively 200 miles further south than in the previous year. Very strong water freshening (Fig. 36a) took place in the inshore waters along the Norwegian coast and in the waters of the Bear Island Current. From the Norwegian coast (Fugløy/Sørøya) the diluted waters spread in a northerly direction and joined the diluted waters of the Bear Island Current. In June, further freshening of the coastal waters occurred. The transport of these waters increased off the Norwegian coast from the area of the Andøy/Fugløy in a northerly direction, and the transport of the diluted waters of the Hope Island/Bear Island Current increased in a southwesterly direction (Fig. 36b). As a result, the high salinity waters of the Barents Sea and the Norwegian Sea appeared to be divided at the surface by a rather wide band of diluted waters.

On the basis of the material from the cruises of the R.V. "Tunetz", dynamic charts of 0—200 decibar were compiled (Fig. 36c,d). A peculiar feature of the dynamic topography is the bend of

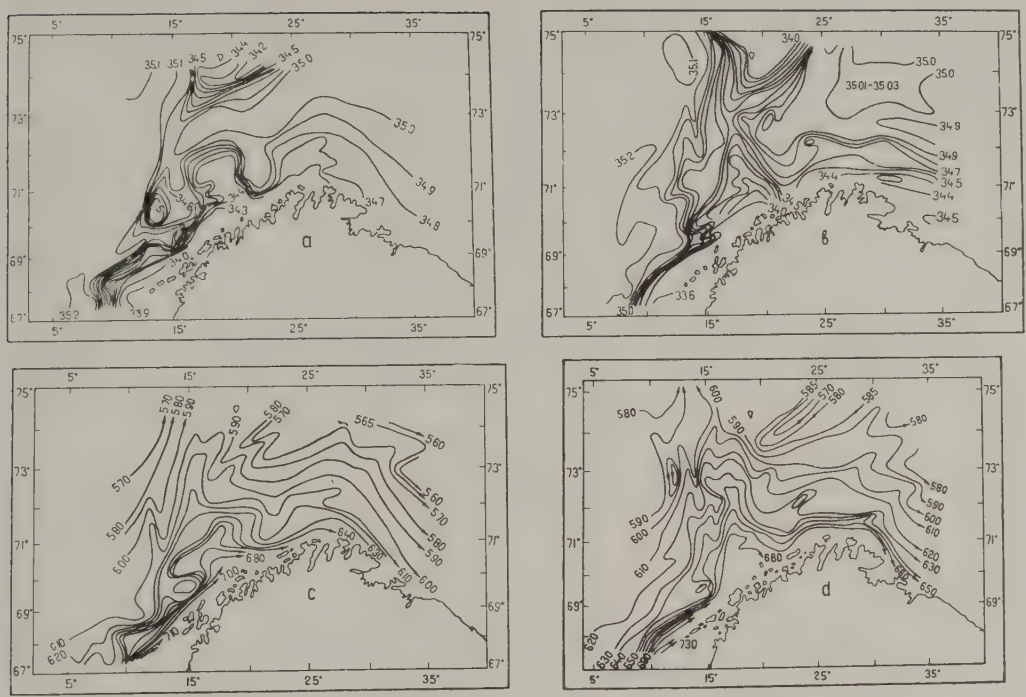

Figure 36. Charts of salinity distribution.
a = the period 18. April to 21. May 1961.
b = the period 3. June to 6. July 1961.
c = 0—200 decibar dynamic chart: 18. April/21. May.
d = 0—200 decibar dynamic chart: 3. June/6. July.

the dynamic contour lines from the Norwegian coast in a northerly direction (the Fugløy). This peculiarity greatly affects the drift of eggs and larvae as such dynamic topography results in transport of eggs and larvae from the coast offwards. Great density of dynamic contour lines off the Lofotens indicates a stable movement of the water masses in a north-easterly direction.

A. G. Kislyakov

Hydrological Conditions in the Barents Sea in 1961

(Figures 37–42; Table 3)

The present paper is based on the observations made in standard sections from the Soviet research vessels "Polyarnik", "Iceberg", "A. Otkupshchikov", "Topseda", "Tunetz", "Bataisk", "Okeanograph", and "CHL-2".

The thermal regime of the Barents Sea is examined on the basis of regular observations in the sections cutting the main branches of the currents. The section between North Cape and Bear Island characterizes the heat content of the waters of the North Cape Current; the section along 74°30′N to the east of Bear Island, the heat content of the northern branch of the North Cape Current; the section along the Kola meridian (33°30′N), that of the Murman Current.

The first half of the year was characterized by the influx into the Barents Sea of waters with temperatures of an average of 0.1°to0.2°C below normal (Fig. 37a—c).

An increase of positive temperature anomalies started in July, reaching maximum in November, and constituting 0.9°C in the section between North Cape and Bear Island, 1.1°C in the section east of Bear Island, between 0.1° and 0.2°C along the Kola meridian Thus in the latter part of the year, considerably greater heating of the northern branch of the North Cape Current took place compared with that of the Murman Current.

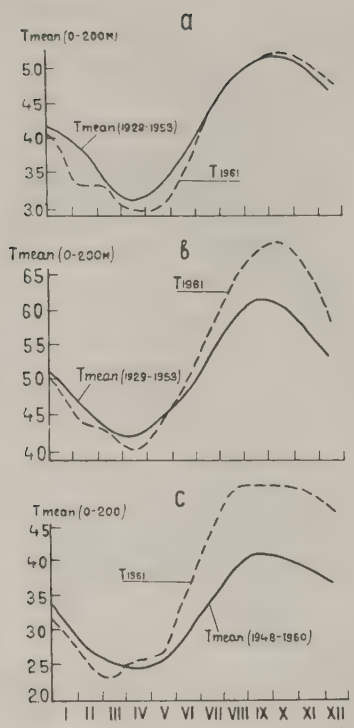

Figure 37. Annual changes of the 0—200 m layer temperature mean.

(a) Section along the Kola meridian (33°30′E).

(b) Section between the North Cape and Bear Island.

(c) Section along 74°30′N to the east of Bear Island.

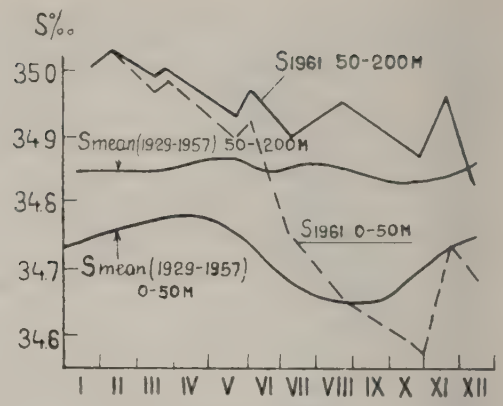

Figure 38. Annual changes of salinity in the section along the Kola meridian (33°30′E).

The increase of the influx of warm waters was also noticeable in the eastern part of the sea, leading to a decrease in the negative anomalies of the temperature. For instance, in the Kharlov section (69°39′N, 38°04′E/71°04′N, 39°25′E) the negative anomalies decreased from −0.7°C in January to 0.0°C in October and in the section across the northern slope of the Kanin Shallow (70°50′N, 41°51′E/71°25′N, 40°32′E) from −1.1°C in February/March to 0.0°C in December (Table 3).

Thus on the whole, the heat content of the water masses in the western part of the sea (to 33°30′E) was 0.3° to 0.5°C above the long-term mean throughout the year, while in the eastern part of the sea negative anomalies prevailed (−0.4°C, −0.8°C).

Table 3. Water temperature anomalies of the 0—200 m layer along standard sections in 1961

Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
Sections													
North Cape—Bear Island (71°33′N, 25°02′E—73°35′N, 20°46′E)	−0.2	−0.2	0.0	−0.2	0.1	0.1	0.4	0.4	0.7	0.8	0.9	0.6	0.3
East of Bear Island along 74°30′N ..... (26°50′—31°20′E)	−0.1	−0.2	−0.2	0.1	0.1	0.1	0.5	1.1	1.0	1.1	1.1	1.0	0.5
Along the Kola meridian (70°30′—72°30′N)	−0.2	−0.4	0.0	−0.2	0.4	−0.1	−0.1	0.0	0.0	0.1	0.1	0.2	−0.1
Kharlov section ..... (69°39′N, 38°04′E—71°04′N, 39°25′E)	−0.7	−0.6	−0.4	−0.4	0.5	−0.6	−0.3	−0.4	−0.4	0.0	0.1	0.0	−0.4
Across the northern slope of the Kanin Shallows ... (70°50′N, 41°51′E—71°25′N, 40°32′E)	−0.8	−1.1	−1.1	−1.0	−1.2	−1.0	−0.3	−0.6	−1.0	−0.8	−0.2	0.0	−0.8

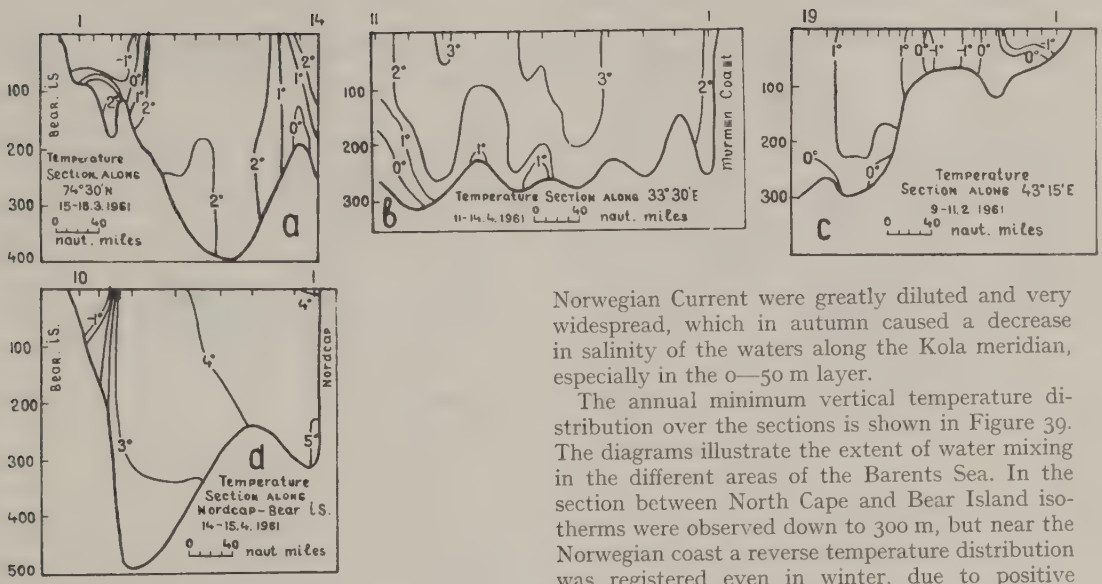

Figure 39. Vertical temperature distribution over the sections in winter.

In 1960 and 1961 waters of abnormally high salinity flowed into the Barents Sea. According to our data, the rise in salinity along the Kola meridian started at the end of 1959/beginning of 1960 and reached its maximum in February 1961. During 1961 a decrease took place, but in the 50—200 m layer positive salinity anomalies remained until the end of the year (Fig. 38).

In 1960 and 1961 the average salinity values in the 50—200 m layer were 34.93‰ and 34.94‰ respectively, the highest values observed for a number of years since 1929. In the 0—50 m layer high positive anomalies prevailed until June, followed by a sharp decline which resulted in below-normal salinities in September/December.

In the period since 1929, an abnormally high annual salinity mean in the surface layer was observed in 1960 (34.88‰). In 1961 it was somewhat lower (34.81‰) and was almost at the level of the years 1948, 1953, 1956, and 1957.

The increase in salinity is connected with a stronger inflow of Atlantic waters and with decreasing land drainage from the Scandinavian Peninsula. In fact, in the spring of 1960, the salinity of the waters of the inshore Norwegian Current was very high. As a result, waters with high salinity were observed in summer and autumn also in the upper layer along the Kola meridian. In the spring of 1961, the waters of the coastal Norwegian Current were greatly diluted and very widespread, which in autumn caused a decrease in salinity of the waters along the Kola meridian, especially in the 0—50 m layer.

The annual minimum vertical temperature distribution over the sections is shown in Figure 39. The diagrams illustrate the extent of water mixing in the different areas of the Barents Sea. In the section between North Cape and Bear Island isotherms were observed down to 300 m, but near the Norwegian coast a reverse temperature distribution was registered even in winter, due to positive stability of the upper diluted layers (Fig. 39d).

The band of cold water with negative temperatures of the Bear Island Current was 40 miles wide and was distributed along the slope down to depths of 100 m. The front separating the cold and warm waters is most distinctly marked from the surface down to 60 m; at greater depths, especially over the Bear Island slope, the front is washed away. From 340 m to the bottom the Bear Island Channel consists of water with temperatures between 2.5° and 2.8°C.

Along the Kola meridian from the coast to 71°N, the homothermic distribution of temperature was observed; further north, as Figure 39b shows, convection does do not reach the sea bed. In the near-bottom layer great vertical temperature gradients are observed. The character of the isotherms reflects the configuration of the bottom.

In the section along 74°30'N (Fig. 39a) within the warm-water area, the homothermic distribution of temperature was observed down to 200—300 m; in the Bear Island Current which is 65—70 miles wide in this area, convection spread down to 60—70 m. As is evident from the figure, under the layer of cold water there were waters with temperature of over 2°C. The origin of the "cupola" of cold water over the bank in the eastern part of the section is connected with the formation in winter of cold water on the Central Elevation of the Barents Sea. In the eastern part of the Barents Sea, isotherms in the

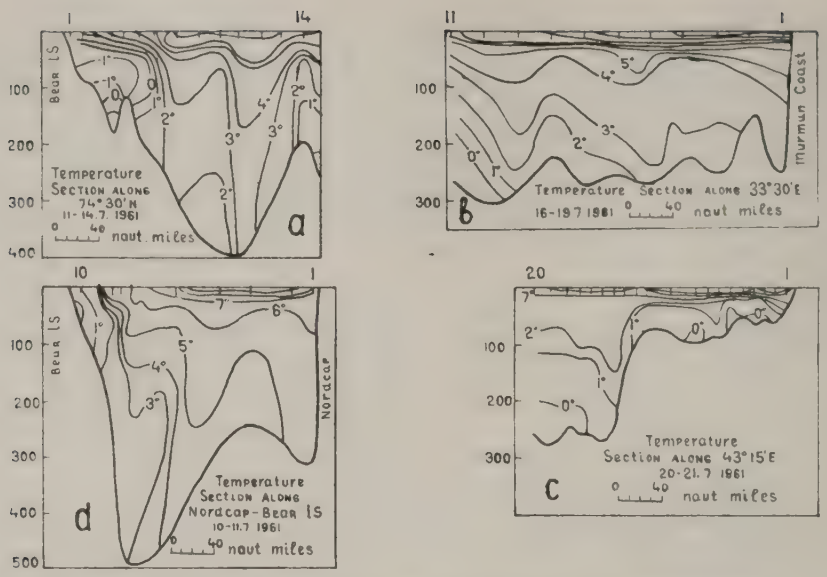

Figure 40. Vertical temperature distribution over the sections in summer.

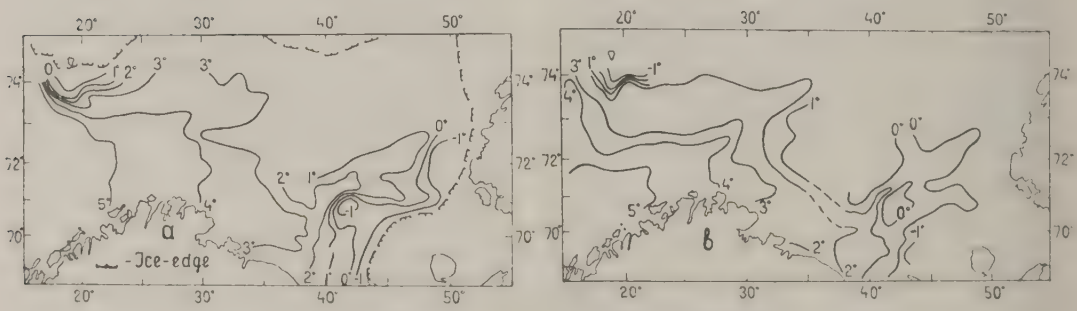

Figure 41. Position of the ice edge and temperature distribution in May.

(a) At the surface; (b) Near the sea bed.

flow of the warm current reached depths of between 150 and 200 m by the end of February; in the coastal area, off the Kanin Peninsula, convection spread to depths of 40—50 m, and on the shallows situated northwards, down to 80 m (Fig. 39c).

Figure 40 shows the temperature distribution in the section in summer. Due to insolation, heating of the surface layers takes place, and the discontinuity layer is formed. Great positive stability of the upper layers results in the fact that in the near-bottom layer, especially over the banks and in shallows where in winter convection reaches the bottom, water with low temperatures remain until autumn.

Figures 41 and 42 illustrate the distribution of temperature at the surface and near the bottom. The near-bottom temperature diagrams show the minimum and maximum temperatures. At the surface, extremes are observed in August and April and therefore the diagrams show the intermediate periods.

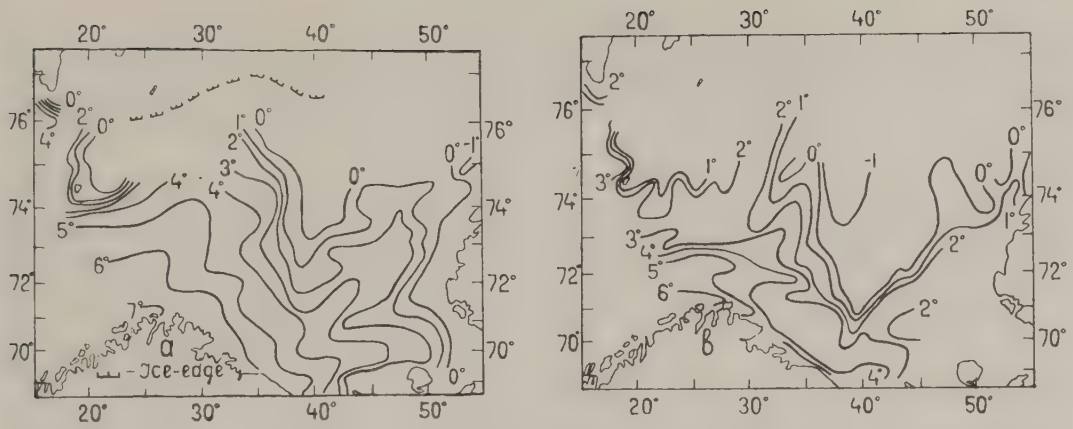

Figure 42. Position of the ice edge and temperature distribution in December.

(a) At the surface; (b) Near the bottom.

Throughout 1961, the positions of the ice edge did not differ essentially from the long-term mean range (Figs. 41a and 42a). An exception was the Bear Island area where the ice edge was 20 to 60 miles to the south-west during the period January to May, and the Kanin/Kolguyev area where it at the same time was registered at a distance of 40 miles to the west.

A. G. Kislyakov, L. I. Borovaya

B. Near Northern Seas

Monthly Anomalies of the Sea Surface Temperature in Areas of the North Sea during 1902—1958

(Figures 43—46; Tables 4—8)

In the Annales Biologiques, Vol. 2, pp. 44—49 and Vol. 4, pp. 57—60 a number of graphs were given illustrating the variation of surface water temperature in some areas and at some stations in the North Sea during the years 1902—1939.

In the following, this investigation will be brought up to the year 1958 for the areas A, B, C, D, and E (see Fig. 43). Furthermore, as the tables recording monthly temperature anomalies for the areas were not published in the above papers they will be given here for the whole period 1902—1958. As additional data have become available also for the earlier years the calculations have been repeated, using the whole material. There are, therefore, minor discrepancies between the tables given here and the graphs published in the above papers.

The material used is the surface temperature observations recorded in the hydrographic card-index of the Council. As standard for the calculation of anomalies is used the grand mean values for the period July 1905/June 1914, published in the "Variations de la température de l'eau de surface de la Mer du Nord pendant les années 1905—1914" (published 1922 in the series Bulletin Hydrographique). For details concerning calculation of the anomalies the reader is referred to Ann. Biol., 2: 44—49.

The results of the calculations for the areas A, B, C, D, and E respectively, are given in Tables 4

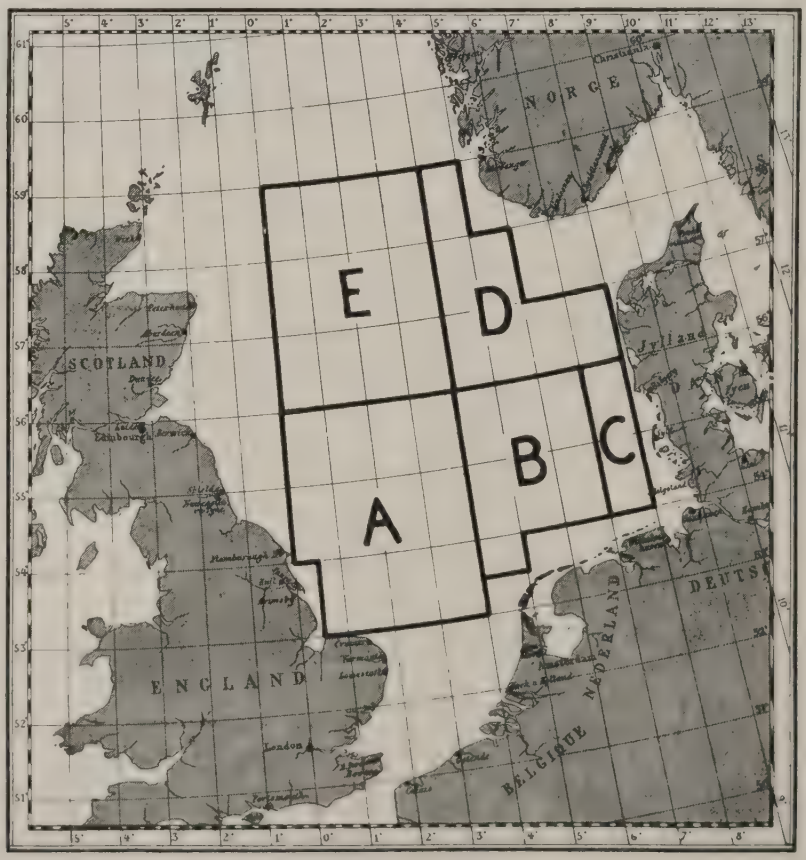

Figure 43. Location of areas.

Table 4. Monthly anomalies (Δ °C) and numbers (n) of observations of the surface temperature in Area A during 1902—1958.

	Jan.		Feb.		March		April		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Aver. of Δ-val.
	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	
1902	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	−0.5	1	0.7	8	—	—	0.1
1903	0.0	2	0.4	42	−0.1	1	0.6	1	−0.1	16	0.1	9	−0.4	15	−1.3	19	—	—	—	—	−0.3	46	—	—	−0.1
1904	—	—	0.1	44	—	—	—	—	−0.6	18	—	—	—	—	0.3	24	—	—	0.6	3	0.4	11	—	—	0.2
1905	—	—	0.0	35	—	—	—	—	−0.6	38	—	—	1.4	5	0.6	40	0.4	44	—	—	−0.8	22	−0.3	5	0.1
1906	0.1	34	0.0	36	−0.6	30	−0.6	39	−0.4	82	−0.6	69	−0.2	55	0.4	85	1.1	100	1.2	118	0.7	86	−0.2	76	0.1
1907	0.0	35	−0.5	36	−0.4	63	0.0	67	−0.4	66	−0.9	41	−1.2	80	−1.0	82	−0.2	92	1.0	116	1.2	84	0.8	53	−0.1
1908	−0.3	42	0.0	37	−0.4	32	−0.3	66	−0.1	39	0.1	47	0.2	92	0.2	74	−0.5	126	0.5	100	0.6	33	0.9	19	0.1
1909	0.2	16	−0.1	39	−0.8	36	−0.7	92	−0.5	53	−0.6	60	−0.9	63	−0.4	39	−0.7	63	0.3	58	0.9	36	−0.5	16	−0.3
1910	0.8	26	0.2	25	−0.1	34	0.1	27	−0.5	52	−0.3	35	−0.9	42	−0.3	136	−0.2	76	0.4	108	−0.6	26	−0.1	29	−0.1
1911	0.7	13	0.3	31	0.2	83	−0.6	46	0.0	39	0.6	19	—	—	1.1	14	1.7	19	0.3	61	−0.2	29	0.1	20	0.4
1912	—	—	−0.4	11	1.3	35	0.9	15	0.6	24	0.4	54	0.8	32	−0.8	46	−2.1	39	−1.5	40	−0.4	62	0.1	22	−0.1
1913	0.8	27	0.3	54	0.1	40	−0.1	28	−0.2	53	0.2	48	−0.8	45	−0.2	64	0.9	53	0.8	43	0.6	30	0.2	26	0.2
1914	0.0	37	0.5	30	0.6	46	1.4	62	1.0	63	0.3	50	0.8	41	0.4	61	1.5	4	—	—	—	—	—		0.7
1915	—	—	0.9	3	0.5	3	0.0	2	−0.4	8	1.3	9	0.2	8	0.7	8	0.3	8	−0.1	5	−3.1	6	—	—	0.0
1916	−0.1	10	−0.3	9	−1.0	6	−0.8	8	−1.2	6	−1.6	7	−1.6	6	0.0	10	0.3	11	−0.5	13	−1.0	7	−1.4	4	−0.8
1920	−0.6	2	0.5	6	0.8	4	0.7	17	0.3	29	0.5	37	−0.2	35	−1.0	19	−0.5	25	0.1	24	0.0	23	−0.1	20	0.0
1921	1.2	39	1.3	83	1.3	60	1.2	42	1.4	62	0.9	70	0.5	41	0.5	49	0.7	53	1.4	50	0.2	41	0.6	39	0.9
1922	0.1	29	−0.4	23	0.0	26	−0.6	16	−0.4	14	0.6	9	−1.6	6	−0.4	4	−0.7	9	−0.8	12	−0.9	33	−0.6	23	−0.5
1923	0.4	22	0.2	24	0.1	38	−0.2	13	−0.4	21	−1.8	17	0.4	8	−0.8	26	−1.1	29	−1.3	22	−1.2	48	−1.4	22	−0.6
1924	−0.5	10	−0.3	13	−1.2	31	−1.2	27	−0.9	29	−0.9	37	−0.9	36	−0.6	45	−0.8	40	−0.8	24	−0.1	23	0.6	29	0.6
1925	0.9	17	0.8	20	0.4	14	0.1	15	0.6	22	0.2	18	0.7	27	0.7	16	−0.3	39	−0.6	65	0.0	53	−1.1	18	0.2
1926	−0.2	26	0.7	21	0.5	34	0.3	41	−0.1	12	0.1	21	0.4	42	0.3	27	1.0	31	−0.1	34	−0.5	17	−0.4	15	0.2
1927	0.1	18	0.6	17	1.1	17	0.5	21	−0.4	17	−0.4	12	−0.5	89	−0.3	37	−0.9	19	−1.2	32	−0.8	23	−0.8	29	0.2
1928	−0.9	16	0.4	18	0.0	20	−0.5	23	−0.8	60	−0.7	45	−0.7	32	−0.2	22	0.3	27	−0.2	33	−0.4	24	−0.6	26	0.4
1929	−0.4	18	−1.1	22	−1.2	30	−1.7	23	−1.3	20	−1.1	56	−0.7	21	−0.6	24	0.7	23	−0.2	171	−0.3	26	−0.2	24	0.7
1930	0.6	24	0.4	21	0.0	27	0.1	18	−0.1	25	1.0	25	0.6	20	−0.5	33	0.1	25	−0.1	70	−0.1	27	0.3	22	0.2
1931	0.6	29	0.3	35	−0.8	33	−1.0	81	−0.5	63	−0.4	65	−0.2	64	−0.9	67	−1.0	64	−0.5	86	0.0	75	0.4	59	0.3
1932	1.2	70	0.9	59	−0.1	65	−0.2	71	−0.4	90	−0.4	87	0.3	103	0.6	74	0.1	54	−0.8	106	−0.6	74	−0.1	70	0.0
1933	0.4	68	0.3	62	0.2	77	0.6	89	0.5	90	0.9	91	1.4	82	1.6	67	1.9	83	1.3	103	0.0	58	−0.7	71	0.7
1934	0.2	70	0.4	69	0.2	75	0.2	74	0.0	94	0.2	101	1.1	110	0.4	96	1.0	116	−0.1	113	−0.2	69	1.2	72	0.4
1935	1.5	112	1.2	65	0.7	80	0.4	105	−0.3	76	0.1	97	1.0	74	1.2	96	0.7	68	−0.4	127	−0.2	110	−0.7	73	0.4
1936	0.2	69	0.1	175	−0.1	72	−0.1	75	−0.2	106	0.1	75	−0.1	58	−0.2	89	1.0	79	0.0	128	−0.2	100	−0.3	28	0.0
1937	0.6	54	0.4	45	−0.3	40	−0.4	44	−0.2	54	0.7	89	0.3	61	0.4	52	−0.1	50	0.9	101	0.8	77	0.2	50	0.3
1938	0.6	52	0.5	69	0.8	68	0.7	75	0.3	96	0.2	76	0.0	85	0.4	77	0.4	83	−0.2	105	0.5	74	0.3	69	0.4
1939	0.4	53	0.6	62	0.4	53	0.3	71	0.0	57	0.6	79	0.4	63	0.6	81		—		—	—	—	—	—	0.4
1946	—	—	—	—	—	—	—	—	−0.7	8	—	—	0.8	14	−0.9	6	−0.9	9	0.5	6	0.0	6	−0.4	6	0.2
1947	0.4	6	−3.6	29	−3.3	30	−2.3	14	−1.2	67	−0.4	28	0.9	21	1.9	23	2.1	28	1.0	29	2.2	19	0.6	17	−0.1
1948	0.4	12	0.4	14	−0.4	60	0.6	34	1.0	67	0.1	42	−0.6	28	−0.1	30	0.2	46	0.6	37	0.8	25	1.8	24	0.4
1949	1.3	71	1.0	67	0.2	56	0.3	77	0.1	49	0.2	42	0.2	28	0.4	26	2.3	37	2.3	32	0.8	27	0.5	23	0.8
1950	1.1	37	1.0	58	1.0	40	0.8	31	0.3	44	0.6	38	0.7	49	0.7	76	−0.3	39	−0.9	63	−0.4	27	−0.7	31	0.3
1951	−0.1	40	0.2	50	−0.2	46	−0.7	26	−0.9	93	0.1	579	−0.1	46	0.2	27	−0.1	30	0.6	60	0.8	23	0.3	29	0.0
1952	0.3	54	−0.2	75	−0.5	190	0.1	64	1.0	61	0.4	39	0.5	37	0.4	47	0.0	24	−1.2	23	−0.9	26	−1.0	32	−0.1
1953	−0.3	52	0.0	27	−0.2	181	0.1	61	−0.2	37	0.3	44	0.3	53	0.3	87	0.5	48	0.8	95	1.4	69	1.6	43	0.4
1954	0.8	39	−0.7	51	0.1	48	−0.1	73	−0.3	127	0.0	95	−0.6	86	−0.6	60	−0.6	128	−0.5	106	0.2	49	0.5	28	0.2
1955	0.0	52	−0.2	69	−1.9	242	−0.9	90	−1.2	113	−1.0	102	0.3	106	1.5	84	1.4	119	0.3	54	0.6	70	0.8	56	0.0
1956	0.7	52	−1.4	92	−1.1	61	−1.1	102	−0.5	49	−0.6	79	−0.3	77	−1.3	64	−0.5	133	−0.1	141	0.5	54	0.4	49	−0.4
1957	0.6	36	1.0	69	1.2	90	0.9	81	0.1	36	0.7	82	0.8	70	0.1	51	−0.5	200	−0.3	131	0.4	69	0.5	57	0.5
1958	0.5	48	0.4	45	−0.5	45	−1.1	67	−1.3	67	−0.9	85	−0.2	64	−0.3	57	0.4	60	−0.1	125	0.8	74	1.3	43	−0.1

Table 5. Monthly anomalies (△ °C) and numbers (n) of observations of the surface temperature in Area B during 1902—1958

	Jan.		Feb.		March		April		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Aver.
	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	of △-val.
1902	—	—	—	—	—	—	—	—	—	—	—	—	—	—	−2.5	2	—	—	−0.1	8	0.3	2	—	—	−0.8
1903	1.1	1	0.6	20	—	—	0.3	6	−0.9	17	0.0	4	−0.3	11	−1.3	24	—	—	−1.1	2	0.7	21	—	—	−0.1
1904	0.1	4	0.3	40	—	—	−0.5	2	−1.0	19	—	—	—	—	1.3	24	—	—	—	—	0.3	17	—	—	0.1
1905	—	—	0.4	35	—	—	—	—	0.0	37	—	—	1.6	2	0.7	43	0.0	10	—	—	−0.9	32	−0.7	5	0.2
1906	−0.5	3	0.4	20	−0.2	10	−0.5	19	−0.1	29	−0.7	7	−0.5	9	0.6	33	0.9	23	1.5	19	1.4	29	−0.3	13	0.2
1907	0.3	12	−0.4	14	−0.4	28	−0.3	15	−0.3	16	−1.3	10	−1.0	8	−1.3	20	0.3	6	2.0	8	1.7	7	1.6	5	0.1
1908	0.5	25	0.7	12	−0.7	16	−0.4	4	−1.1	20	0.6	4	0.4	22	0.2	10	−0.5	4	0.5	20	0.3	3	—	—	0.0
1909	0.2	7	1.8	18	−1.3	28	−1.2	10	−1.8	41	−0.8	5	−1.7	19	−0.8	11	−1.2	10	0.8	1	−0.6	1	−1.2	2	−0.6
1910	—	—	0.7	10	—	—	—	—	0.1	21	—	—	−1.0	2	0.2	5	—	—	0.4	12	—	—	—	—	0.1
1911	0.6	2	—	—	0.0	17	−0.5	2	−1.0	2	0.9	30	—	—	—	—	1.4	2	—	—	—	—	—	—	0.2
1912	—	—	—	—	1.0	5	—	—	—	—	0.1	17	—	—	—	—	−0.6	6	—	—	−0.7	14	—	—	0.0
1913	0.9	3	0.6	12	—	—	—	—	−1.0	12	—	—	—	—	−1.1	2	—	—	—	—	—	—	—	—	−0.2
1914	—	—	—	—	—	—	—	—	0.6	2	−0.9	10	2.6	1	—	—	—	—	—	—	—	—	—	—	0.8
1915	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1916	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1920	0.8	1	1.3	4	0.6	8	1.3	8	3.0	1	0.6	2	—	—	—	—	−0.6	4	−0.2	10	−1.4	6	0.5	7	0.6
1921	0.9	7	1.2	7	1.8	4	1.2	6	1.8	5	0.3	6	−0.2	17	0.1	11	0.2	9	0.8	9	0.0	5	0.3	6	0.7
1922	−0.7	9	−2.0	10	−0.6	10	0.9	10	−0.8	6	0.6	6	−1.1	6	−1.0	6	0.3	6	−1.2	3	−1.1	10	−0.2	7	−0.6
1923	0.4	12	−0.2	14	0.2	14	−0.2	8	−0.8	13	−2.3	18	0.1	12	−0.7	16	−0.9	19	−0.9	17	−1.2	34	−1.5	14	−0.7
1924	−1.5	8	−1.0	2	−2.0	8	−1.9	18	−1.4	24	−1.4	14	−0.4	25	−0.1	23	0.1	15	−0.1	8	0.0	6	0.6	11	−0.8
1925	1.1	6	0.8	8	0.8	6	0.6	6	0.7	8	0.8	8	1.4	8	0.9	18	0.1	24	−0.1	21	−0.1	9	−1.2	8	0.5
1926	−0.6	10	−0.5	8	0.6	35	0.4	8	0.0	4	0.5	4	0.1	8	0.0	8	0.9	7	0.2	8	−0.6	10	0.1	8	0.1
1927	0.2	8	0.8	8	1.2	13	1.0	10	−0.3	8	−1.2	6	−0.5	25	0.7	13	0.3	26	−0.5	28	−0.7	18	−1.4	25	0.0
1928	−0.6	24	0.2	23	−0.3	23	−0.6	24	−0.5	37	−0.7	27	−0.7	28	−0.4	30	0.5	30	0.2	23	0.7	23	0.3	32	−0.2
1929	−0.5	23	−2.3	23	−2.1	28	−2.1	22	−2.5	57	−1.4	30	−0.2	21	−0.5	24	0.5	24	0.4	40	−0.2	24	0.1	27	−0.9
1930	0.3	22	0.2	23	0.1	30	−0.4	17	−0.2	22	0.9	70	1.1	42	0.0	39	0.1	43	0.0	46	−1.6	32	0.3	32	0.1
1931	0.8	38	0.1	31	−0.9	34	−1.0	34	−0.6	64	−0.2	34	−0.1	37	−0.3	35	−0.7	37	−0.4	48	0.1	36	0.6	35	−0.2
1932	1.6	26	1.1	29	0.2	31	−0.4	57	−0.4	56	0.1	39	1.5	40	1.2	32	1.0	35	−0.1	45	0.3	37	0.1	31	0.5
1933	0.3	35	0.3	35	0.1	29	0.3	37	0.5	54	2.1	37	1.4	41	1.7	45	1.9	64	2.0	35	0.6	26	−0.4	23	0.9
1934	0.4	21	0.9	20	0.6	15	0.3	22	0.3	21	−0.1	39	0.7	26	0.8	30	1.6	27	1.0	24	0.7	49	1.6	32	0.7
1935	2.4	51	1.7	17	0.7	38	0.5	21	−0.4	34	0.2	24	0.6	21	0.3	44	0.7	21	0.1	32	0.4	52	0.3	20	0.6
1936	0.7	20	0.3	124	0.2	21	−0.3	25	−0.7	52	1.0	21	0.7	23	0.5	42	0.7	22	0.1	27	0.3	50	0.2	20	0.3
1937	0.7	19	0.2	27	−0.1	82	0.2	21	0.9	48	0.7	21	0.0	33	0.6	34	0.5	21	0.8	27	0.8	34	0.1	25	0.4
1938	0.8	22	0.8	29	1.1	21	1.0	31	−0.1	41	−0.4	56	−0.4	26	1.4	25	0.9	33	0.8	23	1.3	40	0.3	23	0.6
1939	0.5	21	0.8	31	1.1	14	0.2	20	0.1	35	1.5	32	0.7	26	1.3	35	—	—	—	—	—	—	—	—	0.8
1946	—	—	—	—	—	—	—	—	0.0	6	—	—	1.6	5	—	—	—	—	—	—	—	—	—	—	0.8
1947	−0.8	7	−4.7	20	−2.3	2	—	—	−2.2	33	0.6	2	2.2	12	2.9	6	4.5	2	2.2	3	1.9	3	1.2	3	0.5
1948	1.1	16	—	—	0.2	5	0.8	16	1.1	40	0.4	19	−0.1	21	0.4	18	0.0	28	0.0	19	0.6	16	1.6	15	0.6
1949	1.5	18	1.4	12	0.5	18	0.3	33	−0.3	18	−0.4	16	−0.6	21	−0.4	19	1.9	31	2.2	20	1.7	17	0.9	16	0.7
1950	1.2	14	0.7	20	0.8	18	1.0	25	0.6	30	0.4	19	1.1	31	1.3	26	0.3	21	−0.4	21	0.1	20	−0.3	17	0.6
1951	−0.3	23	0.2	25	−0.4	23	−0.6	30	−0.5	45	0.7	34	−0.6	23	−0.4	19	0.3	17	1.0	31	1.6	12	1.1	23	0.2
1952	0.6	22	−0.1	29	−0.4	32	0.0	36	0.8	36	0.0	16	−0.1	21	1.0	79	−0.6	17	−0.9	20	−0.7	22	−0.9	22	−0.1
1953	0.0	27	−0.7	32	−0.3	336	0.0	25	−0.2	35	1.7	26	1.1	31	0.2	107	0.8	35	1.1	56	1.8	40	2.0	32	0.6
1954	1.0	21	−0.6	28	−0.4	31	−0.3	32	−0.4	60	0.5	63	−0.9	72	−0.7	48	−0.2	66	−0.4	37	0.1	30	0.5	22	−0.2
1955	0.2	32	−0.2	38	−1.8	204	−1.4	85	−1.9	56	−0.5	39	1.2	87	2.2	53	2.1	75	0.5	46	0.8	47	1.0	31	0.2
1956	1.0	31	−0.9	25	−1.3	22	−1.4	105	−0.2	24	−0.8	38	−0.8	56	−1.2	62	−0.5	50	0.4	60	0.6	42	0.4	20	−0.4
1957	0.7	20	1.2	40	1.2	46	1.0	46	−0.1	20	0.7	49	1.3	77	1.0	17	−0.1	76	0.2	27	0.1	25	0.5	23	0.6
1958	0.4	25	0.3	22	−0.4	14	−1.3	18	−1.6	38	0.0	36	−0.4	132	−0.2	50	1.6	34	1.0	33	1.5	55	1.5	32	0.2

Table 6. Monthly anomalies (Δ °C) and numbers (n) of observations of the surface temperature in Area C during 1902 1958

	Jan.		Feb.		March		April		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Aver.
	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	of Δ-val.
1902	—	—	—	—	—	—	—	—	—	—	—	—	—	—	−1.2	1	—	—	—	—	0.1	2	—	—	−0.6
1903	—	—	0.4	4	—	—	—	—	0.0	7	−0.1	1	−0.8	7	−1.2	9	—	—	—	—	0.6	17	—	—	−0.2
1904	—	—	0.2	28	—	—	—	—	−1.1	26	—	—	—	—	1.4	12	—	—	0.3	3	0.8	2	—	—	0.3
1905	—	—	0.3	14	—	—	—	—	−0.5	20	—	—	1.4	4	0.9	14	−0.1	4	—	—	−1.2	6	—	—	0.1
1906	0.7	2	0.3	3	−0.9	5	−0.5	8	0.7	10	0.9	3	−1.7	1	0.4	17	1.2	4	1.2	1	1.9	5	−0.6	1	0.3
1907	—	—	−0.9	5	0.5	1	—	—	−0.4	2	—	—	—	—	−0.9	1	−1.6	1	—	—	—	—	1.0	2	−0.4
1908	0.6	2	—	—	−0.2	1	−0.3	1	−1.6	10	—	—	—	—	0.4	4	−0.6	1	0.2	1	—	—	—	—	−0.2
1909	—	—	1.6	2	−1.2	1	−0.7	9	—	—	−1.6	5	—	—	−0.3	2	0.2	3	—	—	—	—	—	—	−0.3
1910	—	—	1.7	2	0.7	5	—	—	0.8	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.1
1911	—	—	—	—	0.5	1	—	—	−0.8	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	−0.2
1912	—	—	—	—	−0.3	3	—	—	—	—	—	—	—	—	0.4	15	−0.4	1	—	—	0.3	1	—	—	0.0
1913	1.4	3	0.7	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.0
1914	—	—	—	—	—	—	—	—	0.4	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.4
1915	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1916	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1920	0.2	4	1.1	4	1.1	10	1.8	4	1.7	4	0.5	7	—	—	—	—	−0.4	14	−1.5	8	−1.7	3	−2.2	4	0.1
1921	1.0	4	0.4	4	1.4	3	2.0	4	—	—	1.3	3	−0.6	25	0.5	5	0.1	5	0.3	5	−1.0	1	−1.1	3	0.4
1922	−2.4	5	−4.0	5	−1.6	4	−1.6	5	−1.4	2	−0.2	3	−1.6	2	−1.3	4	−0.1	12	−2.2	2	−0.8	2	0.4	1	−1.4
1923	0.3	4	−1.0	7	0.7	6	−0.2	1	−0.6	4	−2.0	3	1.3	3	−0.6	1	—	—	−0.4	2	−0.3	2	−2.1	3	−0.4
1924	−4.0	1	—	—	—	—	−1.4	7	−1.4	20	−0.5	2	−0.6	3	0.0	2	0.4	3	1.4	1	—	—	—	—	−0.8
1925	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.9	3	−0.1	16	−0.3	9	—	—	—	—	0.2
1926	—	—	—	—	0.8	8	—	—	—	—	—	—	—	—	—	—	1.5	3	0.9	1	1.3	1	—	—	1.1
1927	1.2	5	1.0	4	1.0	6	0.7	13	−0.4	9	−1.1	11	−0.2	19	0.4	6	1.3	8	−0.4	13	0.3	8	−1.7	19	0.2
1928	−1.6	4	−0.4	8	−0.5	10	−0.9	16	−0.8	17	−1.1	12	−0.1	19	0.0	15	0.8	17	0.6	16	0.8	28	0.1	17	−0.3
1929	−0.8	26	−3.2	25	−3.8	25	−3.1	24	−2.0	74	−1.5	32	−0.9	20	−0.5	26	1.3	28	0.9	27	1.0	28	0.6	16	−1.0
1930	1.0	26	0.7	25	0.1	27	−0.5	34	−1.1	33	0.1	116	0.6	41	0.6	39	0.7	34	0.8	34	0.2	32	0.7	33	0.3
1931	0.7	35	0.5	40	−0.9	45	−1.1	36	−1.0	120	−0.2	42	0.3	42	0.2	39	−0.1	35	0.1	78	0.6	32	0.1	45	−0.1
1932	2.0	32	1.0	41	−0.1	42	−0.4	110	−0.7	53	0.3	45	1.3	38	1.4	45	1.3	38	0.8	39	0.6	35	0.3	37	0.6
1933	1.1	40	0.1	41	−0.2	54	0.1	43	−0.3	104	1.4	34	0.8	38	0.9	40	1.8	60	1.8	29	0.8	34	−1.2	39	0.6
1934	0.8	33	0.7	33	0.1	32	−0.1	43	0.1	42	0.4	68	0.6	51	0.9	69	1.8	53	1.2	36	0.9	42	1.9	37	0.8
1935	2.1	97	1.0	36	0.4	85	0.2	37	0.0	62	0.2	58	0.9	50	0.4	50	0.7	32	0.4	41	0.5	48	0.3	38	0.6
1936	1.3	54	0.7	119	0.2	42	−0.4	51	−0.3	69	0.4	60	1.0	54	0.9	56	1.3	55	0.0	29	0.2	46	0.2	39	0.5
1937	0.8	32	0.0	24	−0.7	93	−0.2	34	0.4	52	0.6	40	0.8	51	1.6	36	1.4	30	1.5	29	1.5	28	0.3	29	0.7
1938	1.2	28	0.9	24	1.2	31	0.9	33	0.1	52	−0.5	86	0.7	32	1.7	43	1.3	43	1.1	29	2.0	29	0.6	29	0.9
1939	0.5	32	1.0	26	0.6	31	0.3	32	0.6	43	1.2	35	0.8	43	1.6	32	2.8	16	−0.2	16	0.5	19	−0.6	16	0.8
1946	—	—	—	—	—	—	—	—	0.9	2	—	—	0.9	4	—	—	—	—	—	—	—	—	—	—	0.9
1947	—	—	—	—	—	—	—	—	−3.6	1	—	—	3.3	1	1.7	1	—	—	—	—	—	—	—	—	0.5
1948	—	—	—	—	1.6	1	1.2	4	1.2	8	0.8	4	0.1	5	0.8	4	0.5	7	0.3	4	1.0	4	2.0	3	1.0
1949	2.3	3	2.4	4	0.4	4	0.1	8	−0.5	4	−0.4	4	−0.8	5	−0.8	4	1.7	8	2.8	5	2.5	4	1.8	3	1.0
1950	2.1	3	1.5	4	1.4	5	1.2	5	0.4	7	1.0	12	1.3	23	1.0	4	0.8	4	0.4	4	0.5	4	−0.5	4	0.9
1951	0.8	4	0.6	4	0.0	5	−0.4	4	−1.0	10	0.4	7	−1.4	4	−0.1	4	1.0	4	1.6	5	1.7	1	1.8	5	0.4
1952	2.3	4	0.5	4	—	—	0.2	5	1.2	7	0.2	1	−0.8	4	0.1	29	0.1	3	−0.3	4	0.7	5	−0.4	4	0.3
1953	0.8	7	−1.1	9	−0.2	164	0.3	22	0.5	29	1.1	27	0.9	24	0.7	23	0.7	25	1.6	24	2.3	26	2.5	11	0.8
1954	2.1	5	−0.1	9	−1.2	8	−0.7	13	0.2	36	0.0	38	−0.8	25	−0.1	18	0.4	18	0.0	20	1.3	6	1.4	4	0.2
1955	0.7	6	0.0	10	−2.0	269	−1.6	26	−1.7	13	−0.7	12	1.0	14	1.9	10	2.0	17	1.0	12	1.4	16	1.5	7	0.3
1956	1.9	4	−1.2	7	−1.7	4	−1.9	60	−0.2	7	−1.9	19	−0.2	14	−0.8	12	−0.3	9	0.8	11	0.8	9	0.5	3	−0.4
1957	1.2	4	1.6	14	1.5	16	1.3	18	0.0	10	0.2	17	1.2	16	0.5	10	−0.2	13	0.1	15	0.6	10	0.9	11	0.7
1958	0.8	8	1.2	5	−0.6	3	−1.0	3	−1.2	10	−0.3	7	−0.1	17	−0.1	8	2.0	8	2.3	8	2.2	15	1.6	8	0.6

Table 7. Monthly anomalies (Δ) and numbers (n) of observations of the surface temperature in Area D during 1902–1958

	Jan.		Feb.		March		April		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Aver.
	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	of Δ-val.
1902	—	—	—	—	−2.7	1	—	—	—	—	—	—	—	—	−2.4	3	—	—	−0.5	8	0.0	15	—	—	−1.4
1903	0.3	2	0.0	36	—	—	−0.6	1	0.4	19	−0.3	20	−0.3	12	−0.8	25	—	—	−0.6	1	0.8	27	—	—	−0.1
1904	0.4	5	0.1	50	—	—	—	—	−0.7	48	−1.6	2	—	—	0.6	30	—	—	0.2	13	0.5	9	—	—	−0.1
1905	—	—	0.4	27	—	—	—	—	0.4	23	—	—	0.5	5	0.9	29	0.1	11	−0.4	5	−0.4	16	−0.2	8	0.2
1906	0.2	2	0.1	21	−1.4	5	−0.7	11	0.1	21	−0.4	2	0.8	11	0.2	31	0.3	5	−0.2	3	0.7	21	−0.2	2	0.0
1907	−2.6	2	−0.3	27	−0.7	20	0.2	3	−0.5	29	−1.2	9	—	—	−0.8	21	—	—	—	—	0.9	3	—	—	−0.6
1908	−0.1	10	0.3	14	0.4	2	—	—	−0.1	31	0.4	2	−0.5	1	−0.1	11	1.5	1	0.6	2	0.5	1	0.8	1	0.4
1909	1.5	1	−0.2	15	−1.1	25	1.5	1	−0.4	12	−2.0	29	−1.1	7	−0.7	9	−0.2	27	—	—	—	—	—	—	−0.3
1910	—	—	−0.2	22	0.1	7	−0.4	2	−0.1	29	2.4	2	0.8	2	0.9	1	—	—	0.3	2	−1.1	1	0.7	1	0.3
1911	0.2	1	−0.1	6	−0.2	26	—	—	0.2	4	2.3	210	—	—	1.3	1	−0.5	1	—	—	0.4	2	—	—	0.4
1912	—	—	−0.4	1	1.3	1	—	—	−0.6	1	−0.5	21	0.9	3	−0.4	10	−1.8	6	−1.2	1	−1.0	17	0.9	1	−0.3
1913	—	—	−0.3	27	0.8	1	0.6	2	−0.2	12	−0.8	3	0.0	3	−0.4	3	0.5	1	0.4	3	0.6	1	1.2	1	0.2
1914	—	—	—	—	0.7	3	0.5	7	0.6	16	0.0	18	3.4	2	0.9	1	—	—	−0.1	1	—	—	—	—	0.9
1915	0.7	3	1.2	4	−0.2	1	—	—	−0.8	1	—	—	—	—	—	—	−0.2	1	—	—	—	—	—	—	0.1
1916	—		—	—	—	—	—		—	—	—	—	−3.1	2	—	—	—	—	0.0	1	—	—	—	—	−1.6
1920	0.4	1	—	—	—	—	−0.2	4	—	—	—	—	0.6	1	0.0	2	−0.1	22	−0.4	2	0.6	2	—	—	0.1
1921	0.8	188	0.7	169	1.2	187	1.2	182	1.9	192	0.3	189	−0.8	136	−0.8	13	−0.3	19	0.5	16	0.2	14	0.4	17	0.4
1922	0.0	11	−2.0	12	−1.0	14	−1.6	9	−1.1	14	0.3	6	−1.1	3	−0.6	3	0.2	11	−1.0	6	−1.1	19	−0.4	14	−0.8
1923	0.6	14	−0.2	18	−0.4	14	−0.6	6	−0.4	16	−2.9	11	0.4	5	−1.5	18	−0.4	20	0.1	14	0.0	15	−0.6	9	−0.5
1924	−0.8	5	−1.7	3	−1.1	14	−1.7	12	−1.3	11	−2.2	8	−1.8	8	0.6	22	1.1	10	0.1	19	−0.2	19	1.1	23	−0.7
1925	1.5	14	1.1	18	0.9	16	0.6	16	0.9	23	0.0	18	1.8	21	1.1	22	−0.7	19	−0.9	27	−0.2	15	−1.4	18	0.4
1926	−0.3	22	−0.7	16	0.2	19	0.6	17	0.2	15	1.1	13	1.2	17	0.1	24	0.9	17	0.5	28	−0.5	13	0.4	15	0.3
1927	1.0	20	1.0	17	1.5	25	0.8	19	−0.4	16	−1.1	14	−0.2	31	1.4	22	0.7	34	−0.7	38	−0.4	32	−1.5	33	0.2
1928	−0.6	34	0.3	36	−0.3	36	−0.2	33	0.3	29	−0.7	33	−1.2	47	−0.8	32	0.2	31	0.2	29	0.8	34	0.5	32	−0.1
1929	0.0	27	−1.9	30	−1.5	39	−1.4	29	−1.4	48	−1.5	35	−0.7	31	−0.7	33	0.2	44	−0.6	36	0.6	38	0.3	35	−0.7
1930	1.0	34	0.4	34	0.4	40	0.0	25	0.5	35	2.0	79	1.2	26	0.9	35	0.3	36	0.3	37	−0.7	31	0.2	35	0.5
1931	0.4	35	0.0	35	−1.0	32	−1.2	34	−0.6	42	−1.1	40	−1.0	37	0.1	36	−0.5	30	−0.6	34	0.3	38	0.4	33	−0.4
1932	0.9	32	1.0	34	0.6	33	0.0	33	−0.1	40	0.1	49	1.1	38	1.4	32	1.1	31	−0.1	37	0.4	34	0.6	28	0.6
1933	0.7	37	0.4	34	−0.1	30	−0.2	38	0.4	39	2.6	33	1.8	43	1.7	37	2.2	40	1.6	29	0.4	24	−0.3	26	0.9
1934	0.8	22	1.0	21	0.9	26	0.3	25	−0.4	29	−0.4	25	0.4	23	1.1	25	1.6	17	1.0	17	0.8	38	1.8	20	0.7
1935	0.5	17	1.6	15	0.6	20	0.3	23	−0.1	36	0.2	21	0.4	20	−0.1	32	0.6	17	0.1	16	0.5	39	0.2	19	0.4
1936	1.1	13	0.4	25	0.0	18	−0.5	16	−0.2	42	1.2	17	1.1	18	1.2	30	0.9	16	−0.2	12	0.6	29	0.2	18	0.5
1937	0.7	16	−0.3	33	−0.4	16	−0.3	22	0.5	43	0.0	15	0.2	24	2.0	30	0.8	14	1.0	19	0.6	25	−0.4	18	0.4
1938	0.8	14	0.9	26	1.4	19	0.9	18	0.1	40	−1.0	14	−0.7	22	1.8	14	1.1	23	1.1	16	1.4	27	0.8	16	0.7
1939	0.9	10	0.3	21	—	—	0.2	12	0.4	16	0.6	13	0.6	10	1.7	24	—	—	—	—	—	—	—	—	0.7
1946	—	—	—	—	—	—	—	—	2.3	1	1.8	1	1.0	4	—	—	—	—	1.4	1	1.2	2	0.6	1	1.4
1947	—	—	−1.2	1	−0.7	6	—	—	−0.9	47	0.2	7	1.7	11	2.9	11	4.2	10	1.9	8	2.2	11	1.6	6	1.2
1948	1.2	1	—	—	—	—	0.9	6	0.9	20	0.8	11	0.6	9	0.9	7	0.1	10	0.2	13	1.4	6	2.2	6	0.9
1949	1.7	13	0.9	2	0.9	8	0.6	12	0.1	14	0.1	8	0.1	13	0.0	7	2.0	18	2.8	8	3.1	7	2.2	8	1.2
1950	2.1	7	0.8	10	1.0	7	1.4	10	1.4	11	1.0	8	1.0	11	1.4	21	1.7	9	0.9	10	0.9	8	0.7	9	1.2
1951	0.6	12	0.4	4	−0.1	10	−0.2	12	0.8	20	0.8	11	−0.4	12	0.6	9	1.4	10	1.8	8	2.1	9	1.7	8	0.8
1952	2.1	10	1.1	9	0.2	13	0.2	19	0.8	39	−0.8	12	−0.5	9	0.4	13	−0.3	12	−0.1	9	0.0	14	−0.4	12	0.2
1953	0.7	15	−0.8	17	0.0	19	0.0	18	0.0	24	1.9	17	2.1	22	0.7	57	0.5	19	0.5	26	1.6	16	1.8	22	0.8
1954	0.9	14	0.2	15	0.5	21	0.3	20	0.6	39	1.4	22	0.0	35	0.4	12	0.4	35	−0.5	17	0.7	14	1.4	11	0.5
1955	0.5	15	−0.3	19	−1.1	51	−0.6	26	−1.0	29	0.0	21	1.5	26	1.2	45	2.2	32	0.3	25	1.3	22	0.9	24	0.4
1956	1.6	14	−0.4	20	−1.5	13	−0.5	31	−0.2	44	−0.3	29	0.6	32	−0.6	37	0.6	34	1.0	12	0.4	15	0.7	20	0.1
1957	0.9	31	0.9	39	1.1	24	0.7	25	0.6	12	0.8	24	1.4	50	0.5	14	0.0	41	0.0	5	0.4	14	0.5	15	0.6
1958	1.3	6	0.5	9	−0.8	10	−1.4	5	−1.6	10	0.3	31	0.3	9	−0.6	27	1.4	22	0.8	17	2.0	23	1.6	10	0.3

Table 8. Monthly anomalies (Δ. C) and numbers (n) of observations of the surface temperature in Area E during 1902–1958

	Jan.		Feb.		March		April		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Aver. of Δ-val.
	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	
1902	—	—	—	—	—	—	—	—	—	—	—	—	—	—	−2.5	3	−0.4	3	0.2	12	0.3	17	—	—	−0.6
1903	—	—	0.1	69	−0.4	4	−0.1	5	0.0	23	−0.7	30	−0.6	9	−1.0	43	—	—	−0.6	6	0.0	24	−0.1	6	−0.3
1904	−0.5	9	−0.4	87	—	—	0.0	1	−0.3	36	−0.3	39	—	—	0.5	103	0.7	3	0.2	24	0.5	49	0.3	3	0.1
1905	—	—	−0.2	95	—	—	0.1	3	0.1	74	1.0	5	1.0	15	0.9	49	0.5	30	−0.9	18	−0.8	46	0.2	32	0.2
1906	−0.2	9	−0.2	54	−0.9	7	−0.6	14	−0.3	38	−0.3	18	0.2	35	0.3	60	−0.4	9	0.2	16	0.0	26	−0.5	14	−0.2
1907	−0.5	5	−0.5	26	−0.8	14	−0.4	14	−1.0	23	−0.8	24	−1.5	26	−1.2	52	−1.2	10	—	—	0.1	11	—	—	−0.8
1908	—	—	0.2	26	0.0	4	−0.8	5	−0.1	53	−0.6	34	0.4	46	0.2	29	0.0	2	0.3	8	1.4	2	0.5	7	0.1
1909	0.9	1	0.0	25	−0.8	5	−0.2	7	−0.1	21	−0.6	25	−1.1	37	−0.7	3	−0.2	38	−0.2	3	−0.6	8	—	—	−0.3
1910	−0.6	2	−0.7	28	−0.2	10	−0.3	4	−0.7	39	1.1	15	0.5	21	1.7	1	0.8	10	0.5	14	−1.2	2	0.0	4	0.1
1911	0.1	1	−0.3	7	−0.3	25	−0.2	2	0.6	19	0.3	36	0.2	24	1.6	5	1.9	9	−0.8	2	−0.4	2	0.4	2	0.3
1912	—	—	−1.3	1	0.4	3	0.4	5	0.0	4	−0.2	17	0.7	16	−1.0	1	−2.0	3	−1.8	2	−0.9	17	−0.7	1	−0.6
1913	−0.1	5	−0.1	31	−0.1	15	−0.1	17	−0.6	27	0.1	23	−0.7	14	−0.3	46	1.0	6	1.1	11	1.0	18	0.3	13	0.1
1914	0.2	17	0.1	12	0.8	15	0.6	23	0.7	42	0.0	26	0.8	29	0.7	17	1.6	7	−0.1	7	—	—	1.4	4	0.6
1915	0.9	6	0.7	19	0.2	13	1.4	11	0.0	18	1.0	11	0.3	12	0.5	15	0.5	6	−0.6	5	−2.8	7	−0.6	2	0.1
1916	−0.7	10	−0.5	9	−1.7	6	−0.9	12	−0.6	9	−1.3	12	−1.3	11	0.5	12	0.7	14	−0.6	13	−1.1	10	−2.0	6	−0.8
1920	0.0	9	1.0	10	0.8	5	0.4	11	0.2	19	0.8	17	0.0	15	−1.0	7	0.0	7	0.4	7	0.6	3	0.2	2	0.3
1921	1.2	11	0.9	9	0.6	1	2.4	5	0.9	5	1.3	9	0.2	20	0.0	17	−0.1	13	0.9	12	0.0	19	1.4	13	0.8
1922	0.3	7	−0.7	5	−0.4	9	−0.8	8	−0.4	20	0.9	9	−0.9	9	−1.2	12	−1.2	12	−0.7	19	−1.4	11	0.3	14	−0.6
1923	0.7	9	0.6	9	0.4	7	0.0	4	−0.2	9	−1.6	12	−0.7	3	−1.0	8	−1.0	9	−1.5	3	−0.8	11	−1.8	3	−0.6
1924	−0.6	4	−1.3	5	−1.2	18	−0.8	19	−1.0	14	−0.9	17	−0.7	11	0.2	28	0.4	21	−0.5	11	−0.3	12	0.4	6	−0.5
1925	0.2	10	0.2	10	0.2	9	0.2	11	0.9	19	−0.1	8	2.1	14	1.1	23	−1.3	6	−0.8	8	−0.6	6	−1.3	7	0.1
1926	−0.6	8	−0.1	7	−0.1	13	0.5	7	0.1	12	0.5	8	1.1	7	0.5	11	1.0	21	−0.1	16	−0.9	7	−0.7	7	0.1
1927	0.0	9	0.4	9	0.8	8	0.1	7	−0.1	9	−1.4	23	−0.4	13	1.5	34	0.8	35	−1.3	31	−0.4	29	−0.8	27	−0.1
1928	−0.7	34	−0.2	31	−0.4	37	−0.4	33	−0.4	35	−0.5	33	−1.0	37	−0.5	45	0.4	41	−0.3	36	0.1	30	0.1	27	−0.3
1929	−0.2	24	−0.8	27	−0.4	46	−0.6	29	−0.6	32	−0.9	34	−0.7	33	−0.6	26	0.5	31	−06	33	0.2	27	0.7	28	−0.3
1930	1.1	35	1.0	31	0.7	33	1.0	33	0.8	44	1.4	73	1.1	80	0.4	41	0.3	46	−0.6	36	−1.0	41	−0.2	42	0.5
1931	0.0	41	−0.2	40	−0.8	39	−0.7	42	−0.4	40	−0.7	47	−0.4	34	0.0	54	−0.1	24	−0.2	35	0.4	36	0.5	32	−0.2
1932	1.1	37	1.0	29	0.6	47	0.3	50	−0.3	52	0.3	39	0.5	43	1.3	48	0.9	37	−0.4	46	−0.3	33	0.4	33	0.4
1933	0.4	39	0.3	31	0.2	39	0.4	34	0.5	49	2.3	30	2.4	39	1.9	59	2.1	65	1.4	37	−0.1	29	0.1	31	1.0
1934	0.6	33	1.1	33	0.8	38	0.8	39	0.2	47	0.4	16	1.6	35	1.1	37	1.3	10	0.2	9	−0.4	20	1.2	12	0.7
1935	1.0	6	1.1	7	0.6	13	0.4	39	0.3	41	0.1	11	0.6	27	0.5	20	0.3	18	−0.3	15	0.3	22	0.4	10	0.4
1936	0.4	4	0.2	17	0.3	10	−0.2	16	0.1	53	1.3	13	1.1	10	1.1	41	1.3	12	1.1	5	0.0	25	0.2	6	0.6
1937	0.6	6	−0.2	29	−0.2	11	−0.7	41	0.4	36	0.6	15	0.1	19	0.7	37	0.4	12	0.6	10	0.9	8	0.3	8	0.3
1938	0.4	6	1.1	7	0.8	8	0.9	12	0.3	44	−0.6	6	0.3	8	2.0	7	1.2	30	0.0	17	1.0	16	1.1	6	0.7
1939	1.4	2	0.8	10	0.8	2	0.6	4	0.0	26	0.0	8	—	—	1.8	15	—	—	—	—	—	—	—	—	0.8
1946	—	—	—	—	—	—	—	—	—	—	—	—	1.6	4	—	—	0.7	7	—	—	—	—	—	—	1.2
1947	—	—	—	—	—	—	—	—	0.5	76	—	—	2.1	6	—	—	2.1	16	0.4	4	−1.0	1	0.8	1	0.8
1948	0.8	2	—	—	—	—	1.2	8	0.9	28	1.2	13	0.0	1	−0.1	5	−0.6	12	−0.6	13	0.0	2	—	—	0.3
1949	1.1	3	—	—	0.4	5	0.2	16	0.3	17	0.5	13	0.2	13	0.6	15	1.9	17	0.8	7	1.6	5	—	—	0.8
1950	—	—	0.8	6	0.8	1	—	—	0.7	14	—	—	1.4	7	1.3	23	—	—	−0.1	8	0.8	1	—	—	0.8
1951	0.0	3	0.0	8	0.0	1	−0.8	6	0.8	7	0.9	12	0.0	19	−0.3	25	0.3	18	0.0	25	0.7	40	—	—	0.1
1952	0.4	4	0.0	7	0.2	27	0.9	38	1.2	30	−0.5	14	0.4	25	0.3	192	−0.6	13	−0.9	10	−0.5	13	0.0	8	0.1
1953	0.3	16	−0.1	16	−0.1	48	0.0	96	0.4	52	0.8	56	1.1	45	0.6	178	0.5	37	0.5	34	0.7	43	1.5	20	0.5
1954	0.9	11	0.3	25	0.3	77	0.3	83	0.2	77	0.5	36	−0.3	71	−0.2	82	−0.1	36	−0.9	30	0.2	31	0.1	9	0.1
1955	−0.1	19	−0.1	24	−0.8	58	−0.6	23	−0.8	81	0.0	70	1.2	58	1.4	81	1.9	54	0.2	39	0.6	15	0.4	30	0.3
1956	−0.1	23	−0.6	22	−0.5	33	−0.4	83	0.1	44	−0.2	83	0.4	78	−0.4	60	0.3	89	0.0	41	0.4	32	0.4	32	0.0
1957	0.4	17	0.9	16	0.7	49	0.4	24	0.0	43	0.8	75	0.4	62	0.7	31	−0.7	64	−1.0	28	0.4	50	1.0	9	0.3
1958	0.5	6	0.0	12	−0.5	12	−0.9	8	−1.2	21	0.3	32	1.4	13	0.2	38	1.7	36	0.1	70	0.8	28	0.7	33	0.3

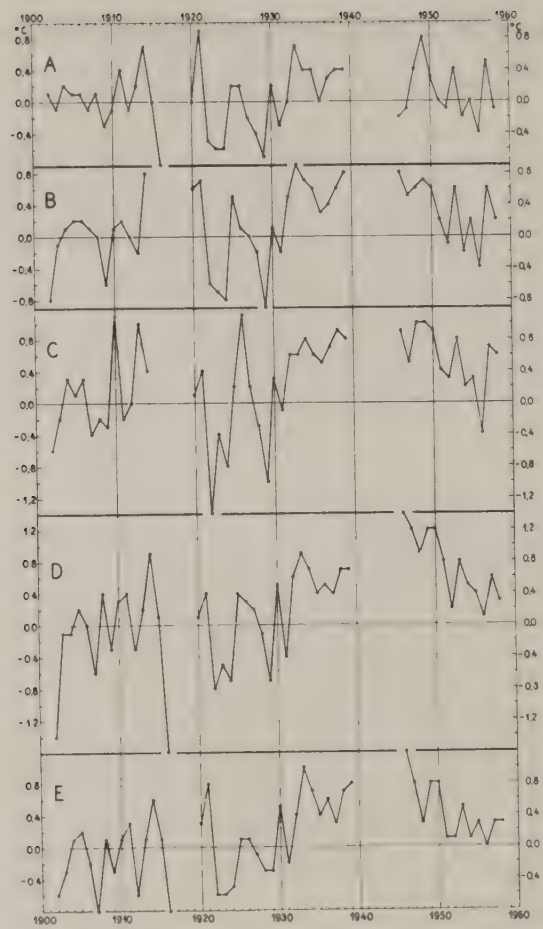

Figure 44. Yearly anomalies of surface temperature in the areas A—E.

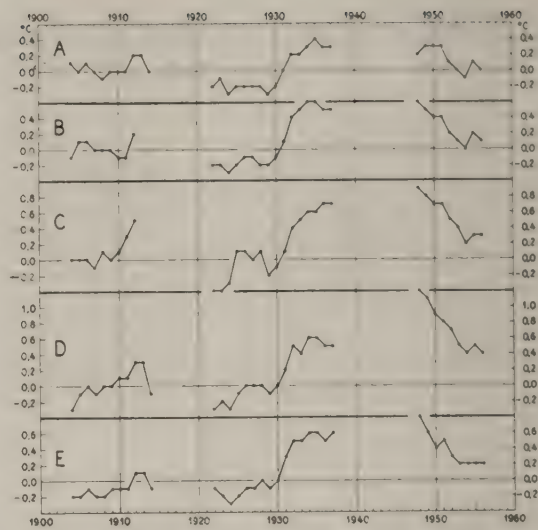

Figure 45. Overlapping 5-year means of yearly anomalies of surface temperature in the areas A—E.

to 8 where monthly anomalies are recorded together with the number of observations on which they are based. For all the areas it appears from the monthly anomalies that whereas during the years 1902/1931 the anomaly is changing between positive and negative values, from 1932 positive values are clearly predominant. This becomes even more conspicuous from the last column of the tables where the monthly anomalies have been averaged for each year.

For each of the areas, these yearly anomalies have been plotted in Figure 44. It shows a rather high degree of conformity between the areas with regard to temperature variations.

The yearly anomalies have then been smoothed out by calculation of 5-year overlapping means. For each of the areas, the result is plotted in Figure 45. The figure indicates that there is a tendency towards lower temperatures in the late 40's and 50's.

The tendency differs considerably from one month to another, however, as appears from Figure 46 where 5-year overlapping means of the monthly anomalies have been plotted for each month separately, except that for areas B, C, and D the first parts of the period have been omitted because of the many gaps in the material.

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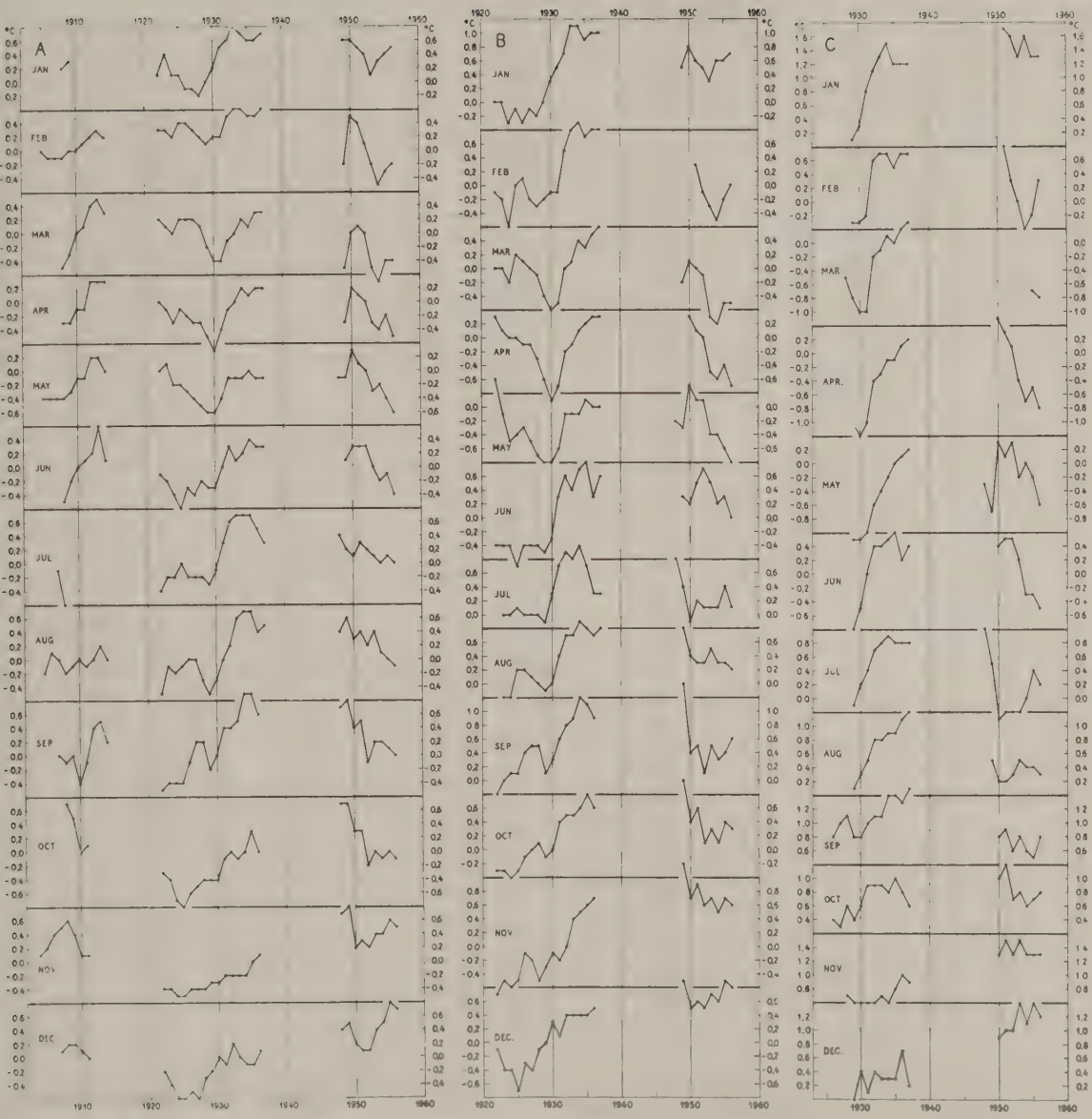

Figure 46. Overlapping 5-year means of monthly anomalies of surface temperature for each month of the year in the areas A, B, C, D, and E.

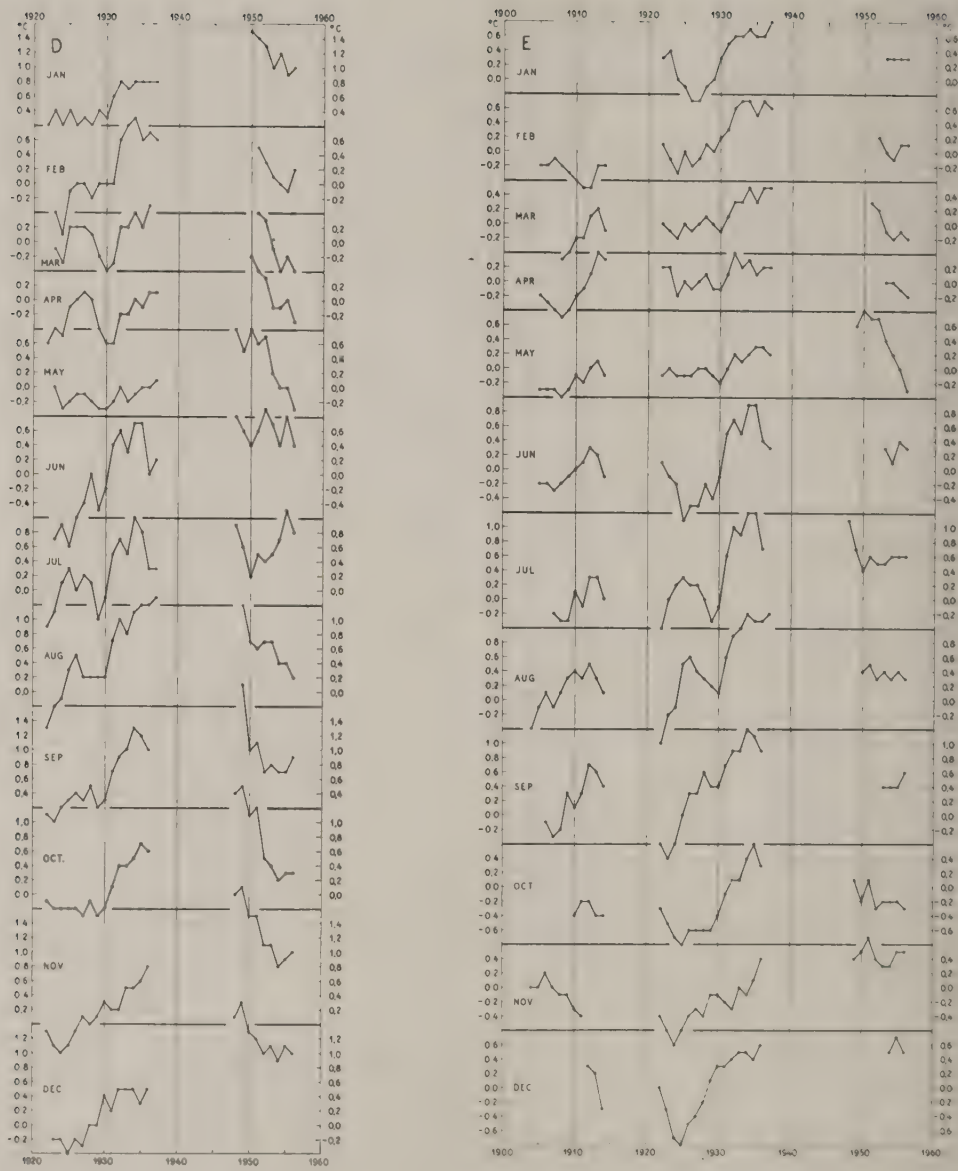

Figure 46 (continued).

Figure 47. Surface and bottom temperature, and salinity expressed as D.C.I. for the period 3. to 25. August 1961.

Hydrographic Surveys of the Northern North Sea, 1961

(Figure 47)

In 1961 further International Surveys were made under the auspices of the Herring Committee. The Scottish results for these surveys, in March and September, will be reported elsewhere.

To supplement these surveys only one survey is being provided this year. This is for August 1961 and is not a very comprehensive survey (Figure 47). The observations suggest that there was in that month an intrusion southwards on longitude 4°E of quite abnormally cold upper water. "Scotia" did not cover this area in any detail and it seems important to bring this phenomenon to general attention for discussion and confirmation.

R. E. Craig

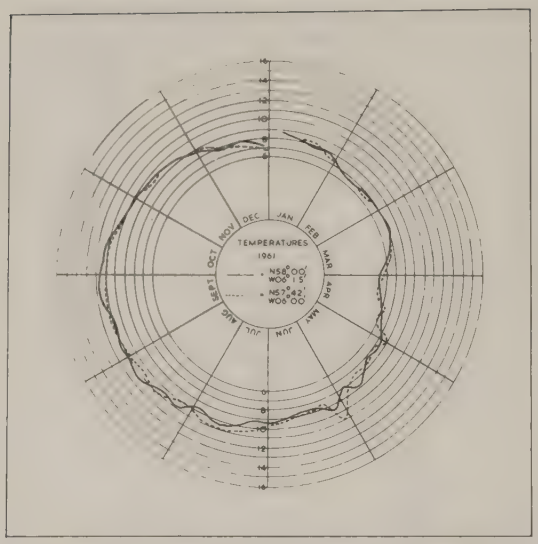

Figure 48. Sea temperature at 3 m depth at two positions in the North Minch, compiled from weekly observations.

Upper Water Temperature in the North Minch, 1961

(Figure 48)

In Figure 48 is shown the variation of sea temperature at 3 m depth at two stations. These data are from a thermograph on R.M.S. "Loch Seaforth" and the Department of Agriculture and Fisheries is indebted to Messrs. David Mac Brayne and Captain Smith for the records.

Temperature was low by comparison with recent years, being about 2°C below 1960. The detailed differences will best be appreciated by comparing the two sets of records.

R. E. Craig

Hydrography of the Kattegat Area
Danish Data

(Table 10)

At the lightvessel "Anholt Nord" the surface salinity did not deviate much from the normal, except in March and July when high salinities occurred, and in October when the salinity was low. At the bottom (30 m) low salinities occurred in July; during the rest of the year the deviations from the normal were insignificant.

The surface temperatures were below normal in July and August and above normal in spring and autumn. At the bottom (30 m) the temperatures were high in May—July and September—November and about normal during the rest of the year.

Helge Thomsen

Swedish Data

(Figures 49–50; Tables 11–12)

The high salinity values observed in 1959 and 1960 are no longer encountered. During three days only of 1961 the salinity measured at "Vinga" at 40 m depth was higher than 35‰ with a maximum of 35.03‰. As in the year 1960, the mean surface salinity at "Vinga" in October was as much as 5‰ below the normal value.

On a cruise in June, hydrography in connection with the occurrence of sprat eggs and larvae was investigated. Figures 49 and 50 show the temperature and salinity distribution at 15 m depth, depicting conditions which seem to be of importance for the future interpretation of the connection mentioned.

Table 9. Monthly means of salinity and temperature at surface and bottom at the lightvessel "Vyl" in SE North Sea (55°24.4'N, 7°33.6'E) for a longer series of years, and deviations from these means

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity					*Surface*							
Mean 1888—1917, 1921—1930	32.6	32.4	32.2	32.4	32.3	32.6	32.5	32.4	32.6	32.4	32.4	32.9
Deviation 1961	0.2	0.5	−0.9	−1.0	—[1])	—	—	−1.9	−1.6	−0.6	0.6	−0.2
					Bottom (20 m)							
Mean 1888—1917, 1921—1930	32.9	32.7	32.7	32.7	32.6	33.0	32.8	32.6	32.7	32.6	32.6	33.0
Deviation 1961	0.4	0.7	0.5	−0.3	—	—	—	−1.6	−1.4	−0.4	0.6	0.2
Temperature					*Surface*							
Mean 1888—1917, 1921—1930	3.2	2.2	2.6	4.8	8.8	12.4	15.2	16.1	15.0	12.2	8.5	5.4
Deviation 1961	2.0	1.9	2.4	2.3	—	—	—	−0.5	0.9	2.5	1.9	0.9
					Bottom (20 m)							
Mean 1888—1917, 1921—1930	3.8	2.6	3.0	4.8	8.0	11.1	14.1	16.0	15.1	12.7	9.1	6.2
Deviation 1961	1.6	1.6	2.1	1.3	—	—	—	−0.4	0.8	2.1	1.6	0.7

[1]) The lightvessel "Vyl" was withdrawn during May, June and July, 1961.

Helge Thomsen

Table 10. Monthly means of salinity and temperature at surface and bottom at the lightvessel "Anholt Nord" for a longer series of years, and deviations from these means

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity												
Surface												
Mean 1931—1960	23.5	23.3	21.2	20.4	18.1	18.5	19.6	20.0	20.5	21.8	22.1	23.3
Deviation 1961	−2.0	−1.5	3.2	0.3	0.2	1.5	2.0	1.1	−1.6	−3.6	0.1	0.7
Bottom (30 m)												
Mean 1931—1960	33.0	33.0	33.1	33.6	33.6	33.5	32.9	32.6	32.6	32.7	33.1	33.0
Deviation 1961	0.5	0.6	−0.5	−0.6	0.2	−0.7	−1.3	−0.6	−0.4	0.3	−0.4	0.4
Temperature												
Surface												
Mean 1931—1960	2.4	1.2	1.8	4.7	9.9	14.5	17.4	17.7	15.4	11.6	7.8	4.9
Deviation 1961	−0.1	0.9	2.3	1.7	0.9	1.0	−1.6	−1.8	0.3	1.5	1.0	−0.1
Bottom (30 m)												
Mean 1931—1960	6.7	5.2	4.6	4.7	4.9	6.5	9.6	12.5	13.4	12.9	11.0	8.7
Deviation 1961	0.4	0.6	−0.1	0.3	1.4	2.2	1.5	0.4	0.7	0.8	1.7	1.6

Figure 49.

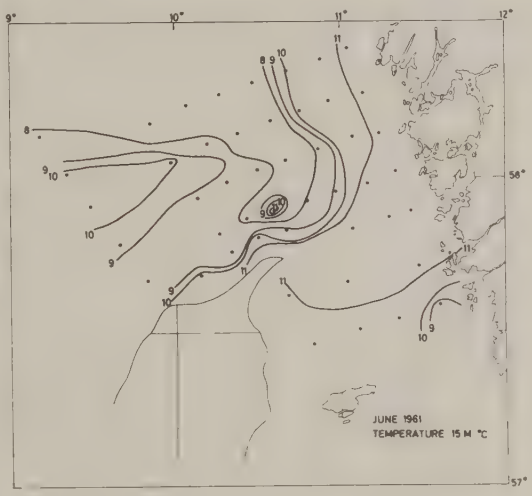

Figure 50.

Table 11.

Depth m	R 43 58°25′N, 09°44′E Date 22/2	21/3	5/9	58°16′N, 10°16′E 31/5
Salinity ‰				
0	31.68	33.23	30.71	31.38
10	32.26	33.28	34.08	33.01
20	33.51	33.27	34.96	34.39
30	34.11	34.52	35.06	34.76
50	34.50	34.77	35.14	34.89
100	34.95	34.80 (97 m)	35.22	35.01
200	35.14	35.05 (193 m)	35.21	35.19
400	35.17	35.13 (387 m)	35.22	35.15
600	35.18	35.14 (580 m)	35.22 (550 m)	—
Oxygen ml/l				
400	5.94	5.91 (387 m)	5.80	—
600	5.22	5.20 (580 m)	5.23 (550 m)	—

Depth m	R 43 58°25′N, 09°44′E Date 22/2	21/3	5/9	58°16′N, 10°16′E 31/5
Temperature °C				
0	4.05	5.51	15.57	12.30
10	4.19	4.21	10.60	11.04
20	5.07	5.52	7.82	6.67
30	6.22	6.15	7.65	6.52
50	6.20	6.41	7.42	6.42
100	6.91	6.07 (97 m)	7.37	6.43
200	6.57	6.50 (193 m)	6.93	7.14
400	6.18	5.93 (387 m)	6.28	6.36
600	6.00	5.96 (580 m)	6.13 (550 m)	—
PO_4–P mg/m³				
400	34.7	28.5 (387 m)	30.4	—
600	43.7	38.1 (589 m)	36.6 (550 m)	—

Table 12. Deviations from long-term means of the monthly values of salinity and temperature at the lightship "Vinga" during the years 1952—1961

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Salinity						*Surface*							
Mean 1930/39, 1947/52	25.1	24.7	23.3	22.5	19.4	20.6	21.9	21.5	23.0	25.4	25.2	24.6	23.1
Deviation 1952	+1.1	−0.1	−0.5	−1.2	+1.9	+3.2	+2.9	+0.5	+0.8	−1.5	−5.0	−1.1	+0.1
,, 1953	−1.9	+0.5	+0.5	−0.7	+0.1	−3.3	−0.1	+1.9	+1.5	+3.0	−1.9	−0.3	−0.6
,, 1954	+2.3	—	—	+1.9	+3.2	+0.6	+1.2	+1.7	+2.4	±0	−0.6	+0.4	(+1.1)
,, 1955	−1.4	−3.3	−3.8	−1.1	+4.1	−0.7	−2.9	−3.0	+0.6	−0.5	+1.5	+4.0	−0.5
,, 1956	+0.4	—	—	−2.3	+0.6	−1.0	−1.9	+2.6	±0	+0.6	−1.0	+1.8	(−0.4)
,, 1957	−0.2	−0.9	−3.2	−0.2	+3.0	+1.1	−0.6	+0.8	+1.0	+1.5	−1.7	+0.5	+0.1
,, 1958	−0.5	+0.4	—	−4.9	+3.7	−1.7	−1.9	+0.2	−3.8	−1.1	−1.5	+0.8	−1.0
,, 1959	+0.4	−0.4	−2.4	−3.5	−1.7	+2.5	−0.2	+1.5	+5.5	−0.4	−0.6	−1.2	±0
,, 1960	+3.7	+2.1	+1.6	+2.9	+0.4	+3.9	+3.3	+2.6	−0.7	−5.6	−2.1	+2.0	+1.2
,, 1961	−1.8	−0.2	+2.8	−2.6	+0.8	−0.6	+0.1	+1.8	−1.3	−5.2	−0.8	+1.6	−0.4
						Bottom (40 m)							
Mean 1930/39, 1947/52	33.8	33.8	34.3	34.2	34.4	34.1	33.8	33.6	33.9	33.5	34.0	33.8	33.9
Deviation 1952	−0.7	+0.3	−0.1	+0.5	+0.1	−0.6	−0.1	+0.1	−0.4	+0.6	+0.5	+0.4	+0.1
,, 1953	+0.2	+0.4	−0.2	−0.5	+0.1	+0.1	−0.4	+0.8	−0.9	+0.5	−0.4	±0	−0.1
,, 1954	+0.2	—	—	+0.3	+0.2	+0.6	−0.1	±0	−0.5	±0	−0.5	+0.2	(±0)
,, 1955	+0.4	+0.7	−0.2	+0.4	−0.5	±0	−0.1	+0.7	−0.3	−0.3	−0.3	−0.3	+0.1
,, 1956	−0.5	—	—	+0.4	−0.3	−0.6	−0.1	−1.1	−0.4	−0.7	±0	−0.4	(−1.4)
,, 1957	+0.3	+0.2	+0.2	+0.1	±0	−0.3	−0.4	±0	−1.2	−1.0	−0.7	±0	−0.2
,, 1958	+0.1	+0.3	—	+0.7	−0.3	±0	±0	−0.6	+0.3	+0.2	−0.2	+0.6	+0.1
,, 1959	±0	+0.2	±0	+0.2	+0.1	−0.3	−0.1	+0.4	−0.3	+0.4	+0.4	+1.0	+0.2
,, 1960	+0.2	+0.5	+0.3	+0.4	±0	−0.2	+0.1	+0.4	+0.1	+1.4	+0.5	+0.1	+0.4
,, 1961	+0.3	−0.3	−1.4	−1.5	+0.1	−0.5	−1.0	−0.9	−0.6	+0.7	−0.2	+0.3	−0.3
Temperature						*Surface*							
Mean 1930/39, 1947/52	2.7	1.6	1.9	4.9	10.2	14.5	17.4	18.0	15.4	11.4	7.7	4.7	9.2
Deviation 1952	+1.0	+0.1	−0.2	−0.2	+0.1	−1.7	−1.3	−1.3	−1.8	−2.0	−2.0	−1.3	−0.9
,, 1953	−1.2	−1.2	+0.7	+0.8	+0.2	+1.3	+0.2	−0.9	−0.1	+1.4	+1.9	+1.9	+0.4
,, 1954	+1.1	—	—	−0.5	+0.7	+0.9	−1.8	−1.9	−0.8	−0.6	−0.2	+0.8	(+1.3)
,, 1955	−0.6	−1.3	−1.8	−1.5	−2.3	−0.7	+1.1	+1.8	+1.4	+0.9	+0.6	+0.3	−0.2
,, 1956	−0.3	—	—	−1.3	−1.3	−0.4	−0.9	−2.7	−1.2	−0.1	−0.9	+0.9	(+0.7)
,, 1957	+0.1	+1.0	+0.2	+0.2	−1.1	−0.5	−0.1	−0.6	−1.4	−0.2	+0.5	−0.1	−0.2
,, 1958	−1.2	−1.2	—	−2.1	−1.9	+0.1	+0.1	−1.6	+0.8	+1.7	+1.2	+0.7	+0.4
,, 1959	−0.1	−0.1	+1.3	+0.8	+1.0	+0.4	+1.5	+1.1	+0.5	+1.2	+1.0	+0.2	+0.7
,, 1960	+0.5	−1.5	−0.8	−0.4	+0.4	+1.0	−1.1	−0.9	±0	−1.1	−0.8	+0.3	−0.4
,, 1961	−0.4	+0.8	+2.3	+1.5	+0.5	+1.3	−1.3	−2.0	+0.1	+1.7	+1.1	+0.2	−0.5
						Bottom (40 m)							
Mean 1930/39, 1947/52	6.1	5.1	5.4	5.0	5.5	7.0	9.3	11.2	12.0	11.8	9.5	7.9	8.0
Deviation 1952	±0	−0.6	−0.7	−0.1	−0.2	+0.4	+0.6	+0.1	+0.9	−1.1	−0.7	−0.4	−0.2
,, 1953	−0.2	+0.3	−0.5	−0.2	+0.6	+0.5	+0.7	+1.6	+2.2	+0.1	+1.1	+1.8	+0.7
,, 1954	+1.2	—	—	−1.5	+0.8	+0.5	+2.3	+0.9	+1.8	+0.6	+0.9	±0	(+1.3)
,, 1955	±0	−0.6	+0.2	+0.2	−0.2	−1.1	−1.8	−3.0	−1.2	+0.6	+0.6	−0.7	−0.6
,, 1956	−0.7	—	—	−0.8	−1.0	−1.8	−2.2	+1.1	−0.1	+0.7	−0.4	−0.6	± 0
,, 1957	+0.2	±0	−0.3	−0.2	+0.7	+0.4	+0.4	+0.3	+2.7	+0.6	+0.5	+0.1	+0.4
,, 1958	−0.3	−0.3	—	±0	−0.4	−1.1	−1.9	−0.5	−1.8	+2.0	+1.9	+1.2	+0.1
,, 1959	+0.3	+0.2	−0.2	+0.6	+0.5	+0.7	−0.5	−0.2	±0	+0.3	+1.1	±0	+0.2
,, 1960	+0.1	−0.1	−1.1	±0	−0.3	±0	±0	+1.0	+0.5	−2.8	−0.5	+0.4	−0.2
,, 1961	+0.9	−0.2	−0.2	+0.5	+1.1	+0.8	+1.1	+2.3	+1.6	−0.3	+2.1	+0.5	+0.8

Table 12 shows the deviations from the normal value of temperature and salinity at surface and bottom at the lightship "Vinga" during the period 1952/1961.

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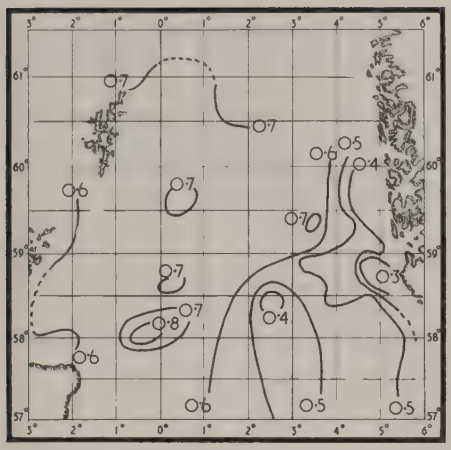

Figure 51. Phosphate, µg-at. PO_4–P/l. 2. March—14. April 1961.

Figure 52. Phosphate, µg-at. PO_4–P/l. 14.—20. April 1961.

Chemical Observations

(Figures 5–58)

Two surveys in March/April and September 1961 yielded fairly complete coverage of the northern North Sea for nutrient conditions. The relevant charts showing temperature and salinity distributions at the times of these surveys are given on p. 43 of the contribution by Mr. R. E. Craig. Although other depths were sampled, only the near-surface nutrient conditions will be described here.

March—April

This six-week cruise began and ended with surveys of the front between Baltic and "oceanic" waters in the vicinity of the Norwegian deeps; in the interval the more general survey was made. These "front" surveys continue the investigation of the environment of the herring fishery located in the Norwegian deeps at this time (Steele, 1961). The beginning of the year levels of phosphate, nitrate, and silicate are well defined for the main North Sea area. Utilization of nutrients by plant life is clearly restricted to the waters near the

Figure 53. Nitrate, µg-at. NO_3–N/l. 2. March—20. April 1961.

Figure 54. Silicate, µg-at. Si/l. 2. March–20. April 1961.

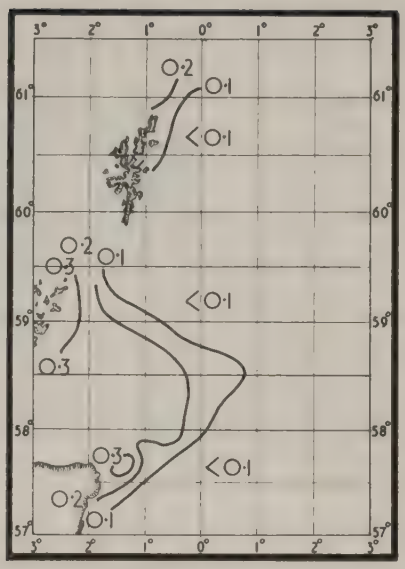

Figure 55. Phosphate, µg-at. PO_4–P/l. 7.—22. September 1961.

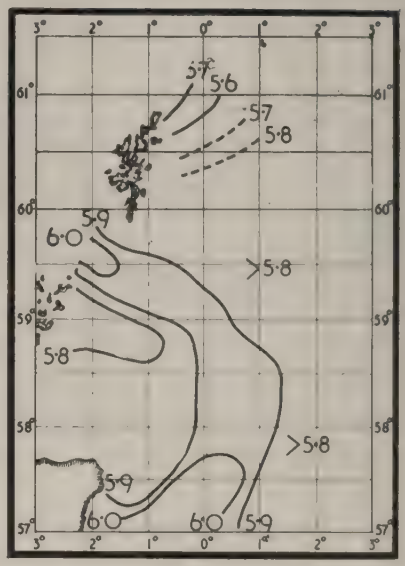

Figure 56. Oxygen, ml O_2/l. 7—22. September 1961.

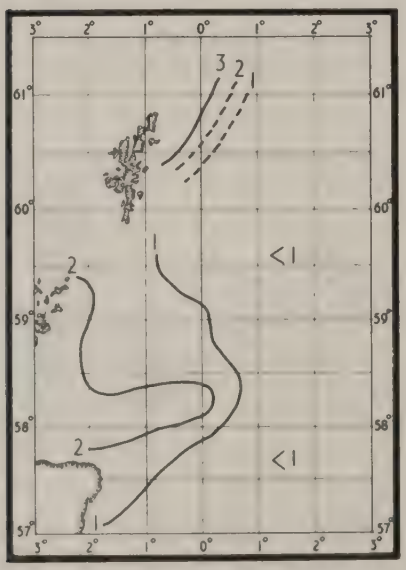

Figure 57. Nitrate, µg-at. NO_3–N/l. 7.—22. September 1961.

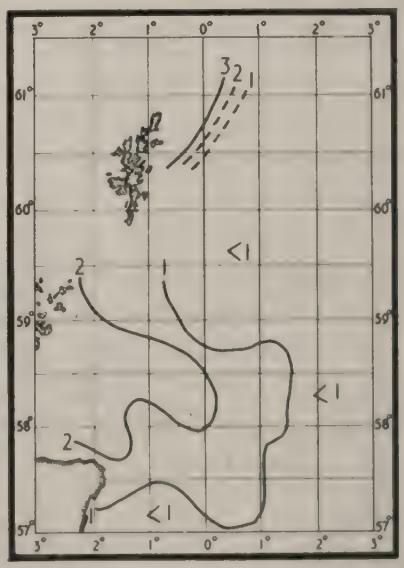

Figure 58. Silicate, µg-at. Si/l. 7.—22. September 1961.

coasts of Norway and of northern Scotland. Pre-growth concentrations of phosphate are between 0.65 and 0.72 µg-at. PO_4/P per litre showing a recession to the level of 1952–3–4 as distinct from the intervening years which were 0.05 units or more richer in phosphate. It is possible that this low level of phosphate has resulted from the abnormally low oceanic incursions during the autumn months of 1960.

Nitrate concentrations cover a wider range than phosphate and again emphasize the strong influence of nitrate-rich oceanic water (cf. BURNS and JOHNSTON, 1962). Silicate distribution also shows a progressive decrease from north to south apart from an unexplained band of less than 4 µg-at. silicate per litre in 59°30′ to 60°00′N. Nitrate concentrations suggest an increase due to recuperation during the winter period but silicate levels apart from minor changes in distribution remained the same during November, December, and March.

September

The present results may be directly compared with those of September 1960 (BURNS and JOHNSTON, 1962) except for nitrate which is included for the first time for this month. The levels and distributions of oxygen, phosphate and silicate differ between the two years in an interesting manner. Detailed comparison of oxygen concentrations in 1961 and phytoplankton numbers shows that oxygen above 5.9 ml O_2/l is associated with populations of above 250 diatoms per litre. The increased oxygen values also tend to lie within the isolines for "low" (0.1 to 0.2) and "exhausted" (less than 0.05) phosphate, or 1 to 2 units and below 1 unit nitrate, or 1 to 2 units and below 1 unit silicate, all of which form more or less coincident boundaries. There was no corresponding pattern in September 1960 when phytoplankton populations were negligible. In addition the levels of phosphate and silicate were lower in 1961 than in 1960 which may perhaps be linked with the lower pre-growth nutrient levels in 1961 or may simply have arisen because of differences in the course of plant production and breakdown.

R. B. BURNS, R. JOHNSTON

References

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C. Baltic-Belt Seas

Danish Observations in Great Belt and the Baltic

(Tables 13—15)

The most conspicuous feature of the year was the extremely high salinities and temperatures in the month of March, indicating a strong inflow of water to the Baltic during that month. At the surface both temperature and salinity deviated more from the normal values than has been recorded for March during the preceding 30-year period. However, the inflow cannot match that of December 1951, when the mean salinity of the surface water at the lightvessels "Halsskov Rev" and "Gedser Rev" amounted to 25.0‰ and 18.7‰ respectively, corresponding to deviations from the normal of 7.6‰ and 6.5‰.

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Table 13. Monthly means of salinity and temperature at surface and bottom at the lightvessel "Halsskov Rev" for a longer series of years, and deviations from these means

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity					*Surface*							
Mean 1931/60	17.4	17.1	14.6	14.6	12.3	13.7	14.0	14.0	15.4	16.7	15.8	17.4
Deviation 1961	−4.0	0.3	6.2	−1.4	1.7	−0.7	1.2	0.5	−3.3	−3.4	2.4	1.0
					Bottom (20 m)							
Mean 1931/60	22.8	23.0	22.2	26.6	27.9	30.5	30.0	28.1	26.2	23.6	22.5	23.1
Deviation 1961	3.0	5.7	6.1	−5.1	−0.7	−1.8	−1.1	0.6	1.4	5.4	0.3	−1.9
Temperature					*Surface*							
Mean 1931/60	2.3	1.4	1.9	4.8	9.4	13.9	17.0	17.3	15.3	11.6	7.8	4.6
Deviation 1961	0.3	1.6	2.9	1.3	1.3	0.9	−1.1	−1.5	0.4	0.7	0.7	−0.1
					Bottom (20 m)							
Mean 1931/60	4.1	2.9	2.9	4.5	6.1	7.0	8.9	11.6	13.2	12.1	9.3	6.3
Deviation 1961	1.3	2.3	2.4	1.3	0.5	0.5	0.6	0.1	−0.4	0.9	0.7	−0.6

Table 14. Monthly means of salinity and temperature at surface and bottom at the lightvessel "Gedser Rev" for a longer series of years, and deviation from these means

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity					*Surface*							
Mean 1931/60	12.0	11.5	10.2	9.8	8.9	9.2	9.5	9.6	10.5	11.6	11.3	12.2
Deviation 1961	−3.0	−0.6	2.6	−0.3	0.2	0.2	0.5	−0.2	−1.6	−1.6	0.9	1.3
					Bottom (15 m)							
Mean 1931/60	14.1	14.2	13.6	14.4	14.4	14.7	14.8	15.3	16.0	15.7	13.8	14.4
Deviation 1961	−1.5	3.0	4.0	2.1	3.0	0.2	−2.5	−4.5	−5.5	−1.1	1.4	0.6
Temperature					*Surface*							
Mean 1931/60	2.4	1.4	1.7	4.1	8.0	12.9	16.3	16.7	15.1	11.8	8.2	4.9
Deviation 1961	0.8	1.0	2.5	1.5	1.9	1.0	−0.9	−1.2	−0.6	−0.7	0.3	−0.2
					Bottom (15 m)							
Mean 1931/60	3.0	1.7	1.8	3.5	6.1	10.1	13.2	14.6	14.4	12.3	8.9	5.5
Deviation 1961	0.8	1.2	2.3	1.7	2.7	1.7	1.4	0.3	−0.9	−0.7	0.4	−0.2

Table 15. Monthly means of salinity and temperature at Christiansø for a longer series of years, and deviations from these means

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity												
Mean 1898/1930	7.0	7.0	7.0	7.0	7.0	7.2	7.4	7.2	7.0	7.0	7.1	7.0
Deviation 1961	0.4	0.5	0.5	0.7	0.7	0.5	0.3	0.3	0.5	0.1	−0.5	−0.6
Temperature												
Mean 1898/1930	3.3	2.1	1.8	3.0	6.1	11.0	15.2	16.0	14.1	11.1	8.1	5.5
Deviation 1961	0.7	1.2	1.8	1.7	1.9	1.7	−0.4	−0.9	0.8	1.6	0.9	0.4

Observations at Swedish Lightships and in the Central Baltic

(Tables 16—17)

The most striking event of the year was the intrusion of new water into the greater depths of the Gothland Deep, according to our measurements in July. In January and April hydrogene sulphide was measured (see FONSELIUS, Fish. Bd Sweden, Ser. Hydrogr., **13**).

In Bornholm Deep there seems to have been more or less stagnation throughout the year.

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Table 16. Monthly means of salinity and temperatures in 1961 at surface and bottom at Swedish lighships with deviations from the 30-year means

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Salinity						*Surface*							
"Sydostbrotten"	—	—	—	5.3	5.3	4.7	4.6	5.3	5.0	5.3	5.5	5.0	—
Deviation	—	—	—	—	+0.4	±0	+0.3	+1.0	+0.4	+0.4	+0.3	−0.3	—
"Finngrundet"	5.8	5.8	5.8	5.9	(5.8)	5.8	5.8	5.6	5.3	5.4	5.7	5.8	5.7
Deviation	+0.4	+0.4	+0.3	+0.4	+0.4	+0.3	+0.4	+0.3	+0.1	+0.1	+0.3	+0.5	+0.3
"Svenska Björn"	6.0	6.1	6.1	6.4	6.0	5.8	5.8	5.8	5.8	6.0	6.5	6.5	6.1
Deviation	−0.2	−0.1	−0.1	+0.3	+0.1	+0.1	+0.3	+0.3	+0.2	+0.1	+0.4	+0.4	+0.2
"Falsterborev"	7.7	8.1	8.3	7.9	7.5	7.8	8.1	8.3	8.0	7.8	8.3	9.5	8.1
Deviation	−0.5	±0	+0.5	+0.4	+0.1	+0.3	+0.2	+0.4	±0	−0.6	±0	+1.2	+0.2
"Oskarsgrundet"	9.9	11.1	14.4	8.3	9.5	10.3	9.0	9.8	8.7	11.6	12.6	—	10.5
Deviation	−1.2	−0.2	+4.2	−1.2	+1.1	+1.5	−0.9	+0.2	−2.1	−0.2	+2.1	—	+0.3
						Bottom							
"Sydostbrotten" (40 m)	—	—	—	5.8	5.8	5.8	5.8	5.8	5.9	5.6	5.6	5.7	—
Deviation	—	—	—	—	−0.3	±0	−0.1	−0.1	+0.1	−0.2	−0.1	−0.1	—
"Finngrundet" (30 m)	5.8	5.8	5.8	5.9	(5.8)	5.8	5.8	5.7	5.5	5.5	5.8	5.9	5.8
Deviation	±0	+0.1	±0	+0.2	+0.1	+0.1	±0	±0	−0.3	−0.2	+0.1	+0.2	±0
"Svenska Björn" (40 m)	6.6	7.0	7.0	7.0	6.8	7.1	7.2	7.0	7.0	6.9	6.6	6.7	6.9
Deviation	−0.3	+0.3	+0.2	+0.2	±0	−0.3	−0.1	−0.7	−0.2	−0.4	−0.3	−0.1	−0.1
"Falsterborev" (10 m)	7.7	8.3	8.4	8.0	7.6	8.2	8.2	8.5	8.1	7.8	8.5	9.6	8.2
Deviation	−0.8	±0	+0.6	+0.4	+0.1	+0.6	+0.1	+0.3	−0.1	−0.9	+0.2	+1.1	+0.1
"Oskarsgrundet" (10 m)	14.3	17.6	18.6	8.3	13.2	11.5	9.2	10.2	9.7	14.6	15.0	—	12.9
Deviation	+0.7	+3.8	+5.0	−4.1	+3.4	−0.7	−2.3	−0.6	−3.0	+0.6	+0.9	—	+0.3
Temperature						*Surface*							
"Sydostbrotten"	(1.4)	—	—	1.3	4.6	10.6	14.4	14.8	12.0	10.3	7.8	4.1	—
Deviation	−0.7	—	—	—	+0.2	+2.2	+0.3	−0.6	+0.1	+2.6	+3.0	+0.9	—
"Finngrundet"	2.0	1.0	0.9	1.6	3.4	8.7	13.0	13.7	12.5	11.3	6.1	3.3	6.5
Deviation	+0.4	+0.2	+0.3	+0.3	+0.2	+1.4	−0.8	−1.9	+0.4	+3.3	+1.0	+0.3	+0.4
"Svenska Björn"	2.8	1.6	2.0	2.9	5.4	11.8	14.1	13.7	12.6	11.5	8.3	5.1	7.7
Deviation	+0.4	+0.4	+0.9	+1.2	+1.2	+2.9	−0.6	−2.1	−0.5	+2.5	+1.7	+0.8	+0.7
"Falsterborev"	3.4	2.3	3.6	5.2	8.2	13.9	14.8	14.1	14.1	12.4	8.4	4.7	8.8
Deviation	+0.5	+0.5	+1.6	+1.5	+0.4	+1.5	−1.0	−2.4	−0.6	+0.7	±0	−0.4	+0.2
"Oskarsgrundet"	3.1	2.5	4.3	5.6	9.7	14.7	15.2	15.1	14.6	12.4	8.3	—	9.6
Deviation	+0.3	+0.6	+2.1	+1.3	+1.3	+1.6	−0.9	−1.6	−0.2	+1.0	+0.3	—	+0.5
						Bottom							
"Sydostbrotten" (40 m)	(2.2)	—	—	1.1	1.9	2.5	2.8	6.7	3.9	7.9	7.7	4.6	—
Deviation	−0.6	—	—	—	+0.3	+0.5	+0.4	+3.5	±0	+1.8	+2.8	+0.7	—
"Finngrundet" (30 m)	2.1	1.1	1.0	1.5	3.1	4.7	5.3	4.4	8.8	9.7	4.7	3.3	4.1
Deviation	+0.5	+0.5	+0.6	+0.4	+0.3	+0.2	+0.1	−0.9	+3.0	+3.2	−0.4	+0.4	+0.7
"Svenska Björn" (40 m)	4.0	3.4	3.1	2.7	3.2	3.9	4.4	4.8	6.7	8.5	8.3	5.5	4.9
Deviation	+1.3	+1.8	+1.8	+1.5	+0.8	+0.7	+0.6	−0.5	+1.1	+2.2	+2.2	+0.9	+1.2
"Falsterborev" (10 m)	3.0	2.3	3.6	5.3	8.1	13.2	14.4	13.3	13.5	12.4	8.5	4.7	8.5
Deviation	0.1	+0.5	+1.6	+1.7	0.6	+1.4	0.2	2.4	−1.1	+0.7	+0.1	0.4	+0.2
"Oskarsgrundet" (8 m)	4.1	3.5	4.6	5.6	9.3	14.5	15.2	15.1	14.6	12.5	8.9	—	9.8
Deviation	+0.7	+1.1	+2.1	+1.3	+1.2	+2.0	−0.6	−1.4	−0.1	+1.0	+0.5	—	+0.7

Table 17. Hydrographic data of the deep basins of the Baltic in 1961

Bornholm Deep

55°15′N, 15°59′E

Depth m	Temp. °C	S ‰	O_2 ml/l	PO_4-P mg/m³	Alkal. millival./l
		11. January			
0	5.09	7.43	—	8.1	—
10	5.06	7.33	8.14	7.4	—
30	5.11	7.37	8.10	8.4	—
50	4.94	8.82	6.43	11.5	—
70	6.77	15.65	2.89	32.5	—
80	5.94	16.33	1.33	39.6	—
87	6.90	17.02	4.01	31.3	—
		16. April			
0	5.68	7.76	—	1.9	—
10	5.52	7.70	8.92	1.5	—
30	4.31	7.70	8.74	1.9	—
50	3.87	12.82	7.09	13.0	—
70	4.06	14.84	6.71	14.9	—
80	5.20	15.57	—	30.4	—
85	5.52	16.32	3.04	37.8	—
		20. July			
0	14.02	7.40	7.46	1.9	—
10	14.01	7.29	7.30	3.7	1.54
30	5.65	7.53	7.66	8.4	—
50	6.61	9.96	5.87	10.2	—
70	5.92	15.65	3.46	33.8	1.87
80	5.71	16.70	1.88	47.7	—
85	5.70	16.98	1.19	57.9	1.91
		15. November			
0	9.45	7.43	—	—	—
10	9.48	7.43	7.24	—	—
30	9.52	7.44	7.20	—	—
50	5.58	8.85	4.22	—	—
70	6.37	15.35	2.52	—	—
80	5.88	15.96	1.77	—	—
90	5.81	16.21	1.21	—	—

Gothland Deep

57°21′N, 19°57′E

Depth m	Temp. °C	S ‰	O_2 m/l	PO_4-P mg/m³	Alkal. millival./l	H_2S-S µg-at./l
		12. January				
0	4.19	7.29	8.39	5.9	—	—
70	4.45	9.88	2.46	28.5	—	—
100	5.31	11.33	1.66	34.4	—	—
150	5.56	12.08	0.73	89.8	—	—
200	5.63	12.59	0	201.3	—	12.0
230	5.60	12.73	0	263.3	—	25.0
		15. April				
0	3.80	7.67	8.80	3.7	—	—
70	3.87	9.65	—	35.6	—	—
100	5.51	11.11	2.27	32.5	—	—
150	5.51	12.19	0.93	92.0	—	—
200	5.61	12.71	0	259.6	—	18.0
225	5.58	12.76	0	298.3	—	23.0
		22. July				
0	16.00	7.18	6.96	1.9	1.54	—
70	4.66	10.08	1.43	67.5	1.71	—
100	5.62	11.54	1.65	35.9	1.78	—
150	5.49	12.64	0.61	121.4	1.87	—
200	5.40	13.06	1.93	70.9	1.83	—
240	5.53	13.28	1.97	56.4	1.77	—
		9. November				
0	10.85	7.06	7.10	5.9	—	—
70	4.06	8.61	3.85	24.2	—	—
100	5.37	11.19	1.37	40.9	—	—
150	5.42	12.36	1.07	81.8	—	—
200	5.40	12.79	1.00	96.6	—	—
225	5.41	13.02	0.24	—	—	—

Landsort Deep

58°35′N, 18°14′E

Depth m	Temp. °C	S ‰	O_2 ml/l	PO_4-P mg/m³
		16. January		
0	3.51	6.79	—	—
70	3.81	9.04	2.67	—
100	4.44	10.15	0.55	—
150	4.77	10.51	—	—
200	4.86	10.60	0.45	—
450	5.11	10.84	0.47	—
		14. April		
0	3.13	6.81	9.23	3.7
70	3.47	8.23	6.10	18.3
100	4.47	10.16	0.67	69.1
150	4.80	10.63	0.44	67.8
200	4.86	10.68	0.47	66.9
458	4.40	10.81	0.61	63.8

Depth m	Temp. °C	S ‰	O_2 ml/l	PO_4-P mg/m³
		23. July		
0	16.21	6.39	6.75	0.9
70	4.03	9.26	2.05	45.8
114	4.90	10.75	0.52	70.6
182	5.06	10.99	0.70	62.6
408	5.14	11.12	0.82	65.4
		7. November		
0	10.19	6.76	7.20	9.0
70	4.03	8.55	4.13	34.7
100	4.67	10.46	0.77	73.1
150	5.04	10.89	0.43	72.2
200	5.10	11.07	0.55	66.9
425	5.16	11.16	0.51	71.9

Polish Observations in the Southern Baltic, 1961

This report is mainly based upon the data collected by the State Institute for Hydrology and Meteorology in Gdynia.

Temperature conditions

The winter 1960/61 was rather mild. In February the surface temperature oscillated slightly about 3°C. In the middle of that month it was somewhat lower in the area of Gdansk Bay, while it exceeded that value (3.3°C) in the Bornholm region. The minimum was observed at 30 m depth in the Arkona basin (1.92°C), evidently in connection with a temporary stronger cooling of the shallow waters of the Danish Sound and Belts.

The summer was not very warm and extremely wet. The maximum temperature at the surface reached hardly 17°C in the eastern part of the Baltic, while in August it was 1°C lower in the western part of the sea, the temperature not differing much from that of July. In the last 10 days of November about 8°C was measured in the whole top layer down to 40—50 m depth.

The "winter water" with temperatures of 4°—5°C in Bornholm Deep (at the lower limit of the top isohalinic waters) prevailed until May; in Gdansk Deep, however, it was observed as late as at the end of November, while the waters with temperatures of 3°—4°C disappeared there, may be in mid-August, but more probably at the end of September.

At the beginning of the year (February/March) a water body below 80 m was encountered in Gdansk Deep with temperatures of 6°—7°C, the temperature thus being about 1°C higher than that of the surrounding waters (5°—6°C). The level of 5°—6°C lasted in the deep waters until the end of the year. Similar conditions were found in Bornholm Deep where at the end of 1960 already, a warm water body had appeared in the 49—90 m layer. The centre of this water mass had temperatures between 8° and 11°C at 50—60 m. Until March the bottom temperature remained at 6° to 7°C, then it dropped by about 1°C, remaining at this level until at least November. An exception was the 60—70 m layer where about mid-year the temperature rose by about 1°, the warmer water layer having become constantly thicker and eventually occupying all the layers below 45 m. Finally, in November, inside this warmer water, a further increase in temperature was observed at depths between 50 and 80 m, thus in November amounting to 7.4°C.

If a comparison is made over a long period of years of the temperature development in the middle and bottom layers of Bornholm Deep, it is obvious that an increase in temperature usually takes place during the second half of the year, and that these increased temperatures last until spring of the following year.

On the basis of the temperature distribution in time and space described above, it can be concluded that the thermic differences between the deep water layers of both the Deeps were rather small in 1961, ranging from 0°C to 2°C.

The temperature differences in the course of the year, especially in the middle layers of Bornholm Deep, were evidently caused by an influx during the winter of waters from the west. The influx was also noticeable at the bottom, not only as to temperature but also in fluctuations of the salinity values.

Salinity distribution

At the surface, salinity values generally lower than 7.5‰ were observed, except in the Bornholm Deep during spring where 7.7‰ was registered. In the Arkona basin and at the entrance to Bornholm Deep salinities of 8.2 and 7.67‰ were measured on 17. May. In Gdansk Deep, in May, the salinity was only slightly above 7‰, at one station, however, 6.85‰ was measured (54°50′N, 19°20′E).

In Bornholm Deep, the lower limit of the top layer (8‰ isohaline) was almost constantly found at 40—50 m; in the region of Gdansk Deep, however, this isohaline was very instable, particularly during the first half of the year; in April it was thus found at about 75 m, and in January, May, October, and November at approximately 50—60 m depth.

The course of the 9‰, 10‰, up to 16‰ isohalines was also quite even in Bornholm Deep, but at the bottom rather considerable fluctuations occurred. On 14.—15. February salinity values of over 18‰ were observed in some places, with a maximum of 18.4‰ in position 55°24′N, 15°21.5′E at 89 m depth and 18.3‰ in position 55°28′N, 14°55′E at 77 m. At the same time, the bottom salinity in the Arkona basin was 19.7‰. The rapid changes in salinity is emphasized, evidenced by salinity values of 16.8‰ and 17.34‰ observed at 89 m depth at another station on 14. and 16. February respectively. On 6. April at 89 m depth at the same station, 16.87‰ was observed, while at 80 m, on the next day, 17.47‰ and, at 89 m, as high a value as 18.64‰ was observed. Thus the differences between the bottom salinity values at the same station and the same time can be over 1.5‰ in as a short a period as one or two days.

In May, values of over 17‰ could still be observed, but in the second half of the year a slow decrease in the bottom salinity of Bornholm Deep was quite evident (16.8‰ at the end of August, 16.9‰ at the end of October, and 16.6‰ in the second half of November).

At station 54°50′N, 19°20′E (Gdansk Deep) the following values illustrate the salinity conditions in the bottom water layer. At the beginning of the year and until April, the salinity remained at a level somewhat higher than 12‰, then in May, August, and October it rose gradually to a maximum of 13.7‰ in October. In the last 10 days of November, however, a difference of −0.9‰ was stated at 107 m depth.

Conclusions

The influx of oceanic water into the Baltic during winter has caused a slight and short spell of improved salinity conditions, which together with the temperature conditions did not differ essentially from those characterized by the author for the period 1951 to 1960. The average values for the bottom waters were the following: 6.2°C and 16.8‰ for Bornholm Deep and 5.8°C and 12.0‰ for Gdansk Deep. Thus the influx of oceanic water in the winter of 1960/61 may be considered of relatively insignificant importance.

A. Głowinska

Results of Soviet Investigations in the Southern Baltic in 1961

The last three years (1959/61) have been characterized by sharp changes in the hydrological conditions in comparison with the period 1956/58. In contrast to these years, when a pronounced decrease in salinity, temperature, and dissolved oxygen content of the bottom layers of the southern Baltic took place, a considerable increase of the values of these characteristics was observed in the period 1959 to 1961, especially in 1961.

High air temperatures, especially during winter and spring caused a heating of the whole water column throughout 1961.

The water temperature was 0.9° higher than the long-term mean. As regards the deep layer of the sea, the positive anomaly was somewhat lower and varied between 0.1° and 0.4°C.

Taking the average values for the period 1949/1961 as standards the mean salinity for 1961 of the 0—80 m layer (Bornholm Deep) or the 0—100 m layer (Gdansk Deep) was normal or 0.5‰ above, respectively. It must be noted that in 1958, i. e. during the period of the lowest salinity in the southern Baltic, the annual mean values of the salinity of the water column in these deeps were below normal by 1.0‰ and 0.5‰, respectively.

In 1961, in the bottom layer, the salinity decreased by 0.2—0.3‰ in comparison with both the 1960 values and the long-term means. This might be explained by a decrease of influx of North Sea waters into the bottom layers of the Baltic. This decrease was compensated for by their comparatively intensive penetration into the intermediate depths, and considerable increase of salinity in the surface layers due to the sharp decline of the discharge from the Neva, Narva, Zapadnaya, Dvina, and Nieman rivers (discharge 20—21% below normal) which took place in 1960 and 1961. Therefore the average salinity of the whole water column increased considerably in 1961 in spite of a decrease of salinity in the bottom layer.

In 1961 the annual mean value of oxygen content in Bornholm and Gdansk Deeps was above average values for the period 1947/1961 by 0.4 ml/l which is indicative of a continuation of the renewal of the waters, which started at the end of 1958.

However, in the deep regions of the Gothland Deep, full renewal of the waters has only taken place late in 1961; and at that time the oxygen content was equal to 1.3—2.1 ml/l (150—225 m) everywhere in comparison with 0.0 ml/l in 1958/60.

Inflow of comparatively renewed North Sea waters was observed in 1960 at intermediate depths (150 m) only.

It seems that the inflow of North Sea waters was not great enough to renew the bottom layers of both the southern and the central Baltic at the same time.

A. E. Antonov

The Components of Phosphorus in Kiel Bay in 1961

(Figures 59–60; Tables 18–22)

Following the recommendations of ICES on long-term observations to be carried out in the Baltic Sea, investigations were started in 1958 not only of microbiomass but also of hydrographical factors. For investigational purposes a station (Boknis Eck, 54°31′N, 10°3′E) in Kiel Bay was chosen, a station which is hardly touched by the in- and outflow at the surface. The contents of total phosphorus and inorganic dissolved phosphorus was examined as representing the concentration of nutrients. In Figures 59 and 60 two isopleth diagrams are shown which illustrate the concentration of total phosphorus and inorganic phosphorus. It appears from Figure 59 that, following an early summer minimum with values of less than 10 μg

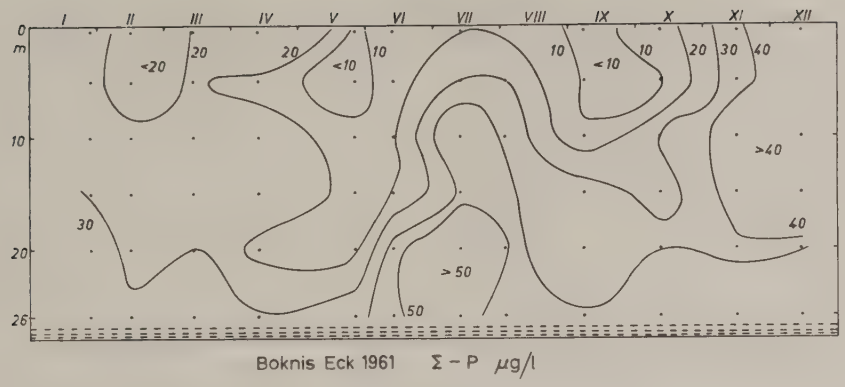


Figure 59.

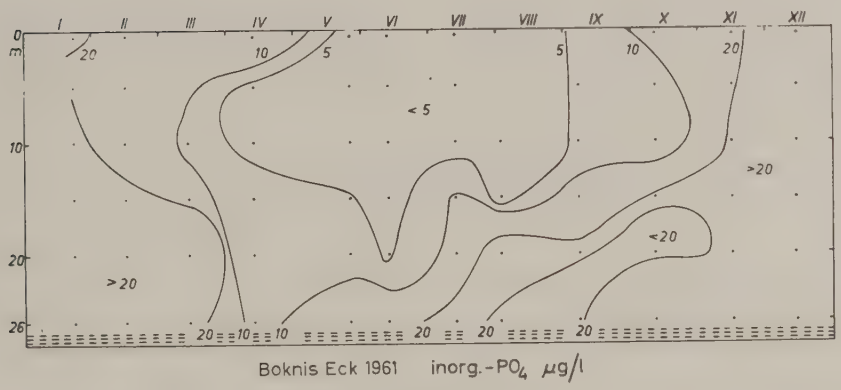


Figure 60.

Table 18. Monthly mean IMK values of total phosphorus and components at station Boknis Eck (Kiel Bay) for the period 1958/1961

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Total P	38.2	34.2	30.7	25.3	22.3	25.6	27.8	31.5	30.8	81.0	65.9	55.5
1961	31.7	18.7	24.1	26.2	14.9	26.1	50.8	38.1	19.6	63.2	41.5	50.0
PO–P.....	21.5	21.5	11.2	5.5	4.6	4.4	8.5	8.5	10.5	21.7	24.7	24.9
1961	22.3	21.8	18.1	8.2	4.8	3.6	8.9	8.4	10.7	40.1	18.7	27.2
Bound P	16.7	12.7	19.5	19.8	17.7	21.2	19.3	23.0	20.3	59.3	41.2	30.6
1961	9.4	3.1	6.0	18.0	10.1	22.5	41.9	29.7	8.9	23.1	22.8	22.8

total phosphorus, especially in the surface layer, values of more than 40 µg total P/l were observed at the bottom from mid-June. In July values of even more than 50 µg were found at 20—26 m depth. In September a surface minimum was observed again with less than 10 µg total phosphorus. A distribution similar in the principal features was observed during four years. As there is a limited exchange in the content of phosphorus between the surface and the bottom layer, IMK values (Integral Mean Concentration) were computed for each month for the total column of water. On this basis annual mean values were calculated for the total phosphorus and components, as shown in Table 18.

The table shows that normally a minimum of IMK values is observed in May and a maximum in October. In comparison, 1961 showed considerable differences, especially an extraordinary maximum in July. Apart from this peak, nearly all other values in 1961 are below the four years' average.

In Figure 60 an isopleth diagram is given of the inorganic phosphorus distribution in 1961. It is evident that throughout the summer in the surface layer down to at least 10 m, values of less than 5 µg P/l are predominant. Only in late autumn are values of more than 20 µg encountered at the surface and, from July, similar high values at the bottom. This annual cycle differs quantitatively from the corresponding isopleth diagram from 1960. In that year relatively high values in the surface layer and values of more than 20 µg in the bottom layer were observed early in May. The corresponding monthly IMK mean values as shown in Table 18 for inorganic phosphorus give as average for the four years a minimum in May/June with less than 5 µg, and a maximum in December with nearly 25 µg/l. It is peculiar that almost all the 1961 observations of PO_4–P are higher than the 4-year mean values, especially those for October. In order to find such yearly differences, mean values for the whole year of all components observed were computed.

Table 19. Annual mean values of total phosphorus in µg/l at station Boknis Eck (Kiel Bay)

Year	IMK	5 m	20 m
1958	27.0	19.9	31.8
1959	41.0	36.4	37.9
1960	52.2	49.9	49.7
1961	33.4	18.7	35.3
4 years' average	38.5	31.7	37.1

From Table 19 it appears that relatively low IMK mean values of total P were observed in 1961. These low values are found again in single water layers, i.e. in the 5 m and 20 m depth zones. Annual mean values were computed in the same manner for inorganic phosphorus (Table 20).

Table 20. Annual mean values of inorganic phosphorus in µg/l at station Boknis Eck (Kiel Bay)

Year	IMK	5 m	20 m
1958	14.0	7.1	13.4
1959	12.3	10.2	19.6
1960	15.5	10.8	16.1
1961	16.1	9.5	19.0
4 years' average	14.5	9.6	17.3

Here it is peculiar that the highest IMK value with 16.1 µg/l during the four-year period of observation was found in 1961. The values for the 5 m and 20 m depth zones do not show any special features.

Bound phosphorus is computed from the difference between total phosphorus and inorganic phosphorus (Table 21).

Table 21. Annual mean values of bound phosphorus in µg l at station Boknis Eck (Kiel Bay)

				% of total P		
Year	IMK	5 m	20 m	IMK	5 m	20 m
1958	13.0	12.8	18.4	48	64	58
1959	28.7	20.2	18.3	70	56	48
1960	36.7	39.1	33.6	70	79	68
1961	17.6	9.2	16.3	52	49	48
4 years' average	24.0	22.1	19.8	62	70	53

Table 21 includes both the phosphorus produced and the dissolved organic phosphorus. This IMK mean value for 1961 is relatively low. It amounts hardly to half that of 1960. The respective values for the 5 m and 20 m depth zones of 1961 are especially low. Hence it may be concluded that little organic matter was produced during the past year.

In Table 22 the IMK mean values of salinity are given for the whole water column as well as for the 5 m and 20 m depth zones. It appears that the IMK values for 1961 show a maximum of 19.5‰ and the figure for the bottom layer (21.3‰) is also higher than usual.

Table 22. Annual mean values of salinity (‰) at station Boknis Eck (Kiel Bay)

Year	IMK	5 m	20 m
1958	16.9	15.0	18.7
1959	18.7	17.2	20.5
1960	19.3	17.8	20.4
1961	19.5	17.4	21.3
4 years' average	18.6	16.9	20.2

Observations are being carried out to determine parallel values for the standing crop of microbiomass and to find a solution to the exceptional situation in 1961.

J. Krey

D. Atlantic Area

Monthly Anomalies of the Surface Temperature in the Celtic Sea during the Period 1948 to 1958

(Figures 61–63; Tables 23–24)

In Annales Biologiques, **8**: 58—62, monthly anomalies of the temperature of the surface water during the years 1903 to 1939 and 1946 to 1950 were published for two areas of the Celtic Sea, viz. P: 50°—52°N, 5°—10°W, and Q: 47°—50°N, 5°—10°W (see Figure 61).

Temperature data for these areas are now available also for the years 1951/1958. Furthermore, part of the material for the years 1948, 1949, and 1950 has been redrawn, as being unreliable, by the institution responsible for the collection of it. In view of this, it was found appropriate now to calculate anomalies of the surface temperature in the two areas for the years 1948 to 1958.

As normals for the 1°-squares were taken the grand monthly means of the surface temperature

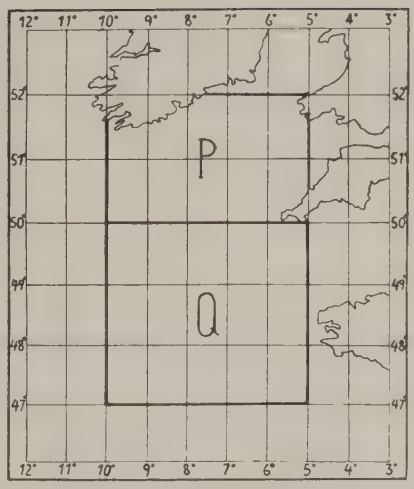


Figure 61. Location of the areas considered, P and Q

Table 23. Monthly anomalies (Δ °C) and numbers (n) of observations of the surface temperature in the Area P during the years 1948 to 1958

	Jan.		Feb.		March		April		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Aver. of Δ-val.
	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	
1948	0.8	9	0.3	9	0.8	10	0.7	7	1.1	11	−0.2	10	−1.3	9	0.0	8	−0.1	8	0.6	8	0.8	8	1.0	8	0.4
1949	0.8	8	0.9	8	0.9	9	0.8	8	0.6	8	1.0	8	1.7	8	1.4	8	2.3	8	2.2	8	1.3	8	1.0	8	1.2
1950	1.0	8	0.6	8	0.9	9	0.6	32	0.6	22	1.4	34	0.7	17	0.5	15	−0.2	17	−0.1	16	0.3	11	−0.4	11	0.5
1951	−0.2	19	0.1	14	−0.1	14	−0.4	20	0.5	20	0.5	25	0.7	20	0.0	19	−0.4	24	0.5	19	0.9	14	0.8	12	0.1
1952	0.5	12	0.0	9	0.5	13	0.4	12	0.9	33	0.3	27	0.4	17	0.0	16	0.0	14	−0.2	24	−0.2	11	0.0	12	0.2
1953	0.1	12	−0.3	18	−0.4	56	0.2	30	0.0	20	−0.4	26	0.2	13	0.3	22	0.3	11	0.4	11	0.6	13	1.3	12	0.2
1954	1.3	13	0.6	11	0.3	19	0.3	18	0.0	22	−0.1	14	−1.3	14	−1.2	18	−0.6	12	0.3	12	0.8	9	0.3	11	0.1
1955	0.6	10	0.0	10	−0.9	44	−0.2	35	−0.3	17	−0.7	11	1.5	12	3.2	32	1.0	24	1.1	46	0.3	54	1.0	13	0.6
1956	0.8	13	0.0	12	−0.2	20	0.1	35	0.4	21	−0.7	19	−0.7	12	−0.8	12	−0.9	12	0.1	13	0.4	11	0.7	12	−0.1
1957	0.5	12	0.4	11	0.9	63	1.0	54	0.6	24	0.9	19	0.6	11	−0.3	10	0.2	16	0.3	26	0.6	22	0.4	13	0.5
1958	0.5	12	0.8	16	0.2	13	0.6	14	0.8	29	0.1	17	−0.4	13	−0.2	12	1.4	11	1.1	12	1.8	10	1.8	9	0.7

Table 24. Monthly anomalies (Δ °C) and numbers (n) of observations of the surface temperature in the Area Q during the years 1948 to 1958

	Jan.		Feb.		March		April		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Aver. of Δ-val.
	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	
1948	0.3	8	0.5	16	0.8	16	0.8	25	1.7	24	0.4	8	−0.6	11	−0.4	4	−0.2	14	0.7	8	0.4	13	1.2	5	0.5
1949	1.1	2	1.6	6	1.8	5	2.6	3	0.6	14	1.8	6	2.9	5	1.8	15	0.8	11	2.1	4	2.2	5	0.9	6	1.7
1950	1.4	12	0.1	5	1.2	6	0.6	39	0.5	42	1.1	55	0.7	42	0.7	60	−0.1	32	0.1	27	−0.1	27	−0.1	24	0.5
1951	−0.2	86	0.0	67	0.3	57	0.9	54	−0.2	56	0.3	60	0.8	59	0.4	63	0.4	48	1.0	47	0.9	49	1.2	32	0.4
1952	0.6	34	0.4	32	0.7	40	0.6	32	1.1	40	0.7	40	0.4	38	1.4	32	−0.4	32	−0.7	33	−0.4	24	−0.2	32	0.4
1953	−0.3	32	−0.3	42	−0.1	51	0.0	40	0.3	51	−0.2	63	0.2	12	1.2	72	0.6	32	0.6	24	0.4	61	1.3	32	0.3
1954	1.2	33	0.5	55	0.4	42	0.5	32	0.0	64	0.6	8	−1.6	17	−1.0	74	−0.4	32	0.3	32	0.5	19	0.3	24	0.1
1955	0.2	15	0.5	16	−0.3	33	0.3	13	0.0	51	0.2	48	1.1	29	2.7	75	2.4	49	0.6	47	0.2	65	0.6	40	0.7
1956	0.5	47	0.1	49	0.0	75	−0.2	57	0.5	22	−0.6	56	−0.3	32	−0.8	35	−0.5	32	0.8	40	−0.1	38	0.6	32	0.0
1957	0.3	54	0.7	51	1.0	78	1.1	49	0.5	35	0.8	41	−0.1	32	−0.1	59	−0.3	57	0.3	37	0.0	38	0.1	40	0.4
1958	0.1	35	0.5	51	0.5	49	0.5	21	0.4	34	−0.3	35	−0.3	39	0.0	32	1.2	24	1.1	35	1.8	16	1.2	4	0.6

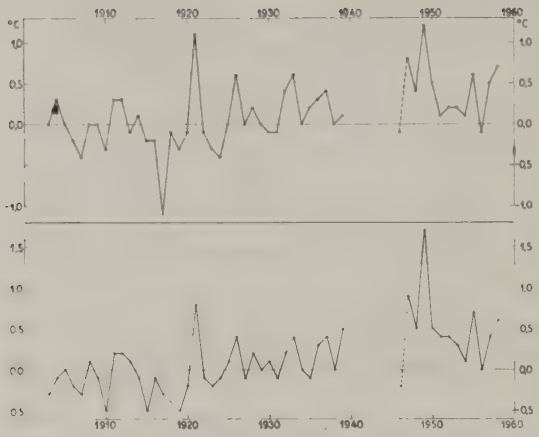


Figure 62. Yearly anomalies of surface temperature in the areas P (upper graph) and Q (lower graph).

for the period 1900 to 1937, computed by SANDSTRÖM on the basis of the data contained in the Hydrographic Card Index of ICES (Rapp. et Proc.-Verb., **112**: 63—75). For details in connection with the calculation of the anomalies the reader is referred to the contribution mentioned above, covering earlier years.

The monthly anomalies of the surface temperature, together with the numbers of observations are given in Tables 23 and 24 for the areas P and Q respectively. With exception of the year 1956,

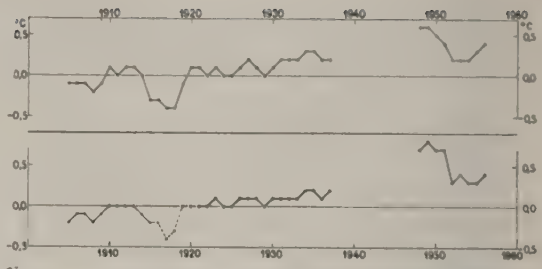


Figure 63. Overlapping 5-year means of surface temperature anomalies in the areas P (upper graph) and Q (lower graph).

positive anomalies are predominant during the years here considered, which is especially conspicuous in the last column of the tables where the monthly anomalies are averaged over the year.

The yearly averages of the monthly anomalies in the areas P and Q are for the whole period 1903 to 1958 plotted in Figure 62. It appears that positive anomalies are predominant from about the mid-twenties. This becomes even more conspicuous in Figure 63, which shows for each of the areas P and Q 5-year overlapping means of the values plotted in Figure 62. (As no data are available from Area Q in 1918, the values plotted in the lower part of Figure 63 for the years 1916 ... 1920 are means of four yearly values only.)

JENS SMED

PART II.

PLANKTON AND BENTHOS

A. Distant Northern Seas

Results of Soviet Investigations on Plankton in the Norwegian Sea and the Barents Sea, 1961

(Figure 1; Table 1)

In 1961 observations on the plankton development in the Norwegian and Barents Seas, chiefly in relation to the food of fishes and their larvae, were continued by the scientific staff of the Polar Institute.

In the early stages of development, cod larvae feed mainly on nauplii of *Calanus finmarchicus* and therefore special attention was paid to the spawning terms of this copepod and the duration of the nauplii stage. These observations were made in the period April to July off the north-west coast of Norway and in the Barents Sea (west of the Kola meridian, 33°30′E).

The beginning of development of the plankton and the amount of feeding organisms present during the spring/summer season influence the duration of the feeding period of the adult Atlanto-Scandian herring in the Norwegian Sea. Over the period March to July, observations were carried out in the waters inhabited by these herring on the state of the plankton as a food basis. In June, as in previous years, plankton samples were collected over the whole Norwegian Sea (cf. A.F. Timokhina, C. M. 1961, Doc. No. 119). As a result of the comparison of the data obtained with those of previous years, the main features of 1961 were revealed.

Phytoplankton

In the area of the Norwegian Shallows the biological spring started somewhat earlier in 1961 than in 1960. Mass production of diatoms and *Phaeocystis* was observed in that area in the week 20. to 26. April.

Abundant development of *Thalassiosira gravida*, *Thalassiosira decipiens*, *Th. longissima*, *Chaetoceros decipiens*, *Coscinodiscus* sp. and *Peridinium depressum* was observed in April/May 1961 near the Lofotens and in the south-western part of the Barents Sea. A peculiar feature of the year 1961 was the absence from the Barents Sea of *Phaeocystis pouchetii* in April/May. During the same period of 1959, this species was observed in great numbers off the north-western coast of Norway and in the Barents Sea. In 1960, mass production of *Phaeocystis pouchetii* was registered on the section North Cape/Bear Island. In 1961 the development of *Phaeocystis* as small patches was recorded only in June/July near Bear Island, on the section North Cape/Bear Island and along the Kola meridian (33°30′E).

In 1961, as early as June/July the summer species of phytoplankton (*Rhizosolenia* sp., *Ceratium* sp., *Peridinium* sp.) developed in the SW Barents Sea.

Zooplankton

The main components of both the spring and summer plankton populations of the Barents Sea and the Norwegian Sea were *Calanus finmarchicus*, *Pseudocalanus elongatus*, *Microcalanus pusillus*, *Metridia* spp., and *Oithona similis*. In connection with a high degree of dilution of the inshore waters in the spring, such neritic species as *Acartia* spp. and *Temora longicornis* were also widespread.

In 1961, unlike 1959 and 1960, the development of *Calanus* began at the same time both in the open sea and in the inshore waters, approximately during the first 10 days of April. In 1959 and 1960, *Calanus* of the inshore waters developed earlier than in the open sea. In 1960 the spawning of *Calanus* off the Norwegian coast began as early as the end of March, while in 1959 it began at the same time as in 1961, i. e. at the beginning of April.

In the SW part of the Barents Sea in the second half of April and in early May 1961, the quantity of eggs and nauplii of *Calanus finmarchicus* was enormous (amounting to an average of 225 eggs per m^3 and 555 nauplii per m^3).

In April of 1959 and 1960, the abundance of eggs and nauplii of *C. finmarchicus* was less while in the open sections of the sea spawning had not yet started and the mature specimens were the dominant forms (Figure 1). In the spring of 1961, spawning of *Calanus* was prolonged and was not so intensive as in 1960. Even at the end of April when young *Calanus* (copepodite stages I—III) appeared, the nauplii stages continued to prevail.

The highest amount of *Calanus* observed in the SW part of the Barents Sea in April/May 1961 was 87,043 specimens on average per 1 m^2. For the last three years, the lowest number of *Calanus* was observed in 1960 (54,201 specimens/m^2).

In connection with the early start of spawning, the population of *C. finmarchicus* consisted as early as May 1961 of copepodite stages III—IV—V, the abundance being minimum. Red *Calanus* (copepodite stages IV—V) developed somewhat later and in June/July they were found along the north coast of Norway up to North Cape. In the waters between the sections North Cape/Bear Island and the Kola meridian, *Oithona* sp. and *Oncaea borealis* prevailed in June.

In the eastern and central areas of the Norwegian

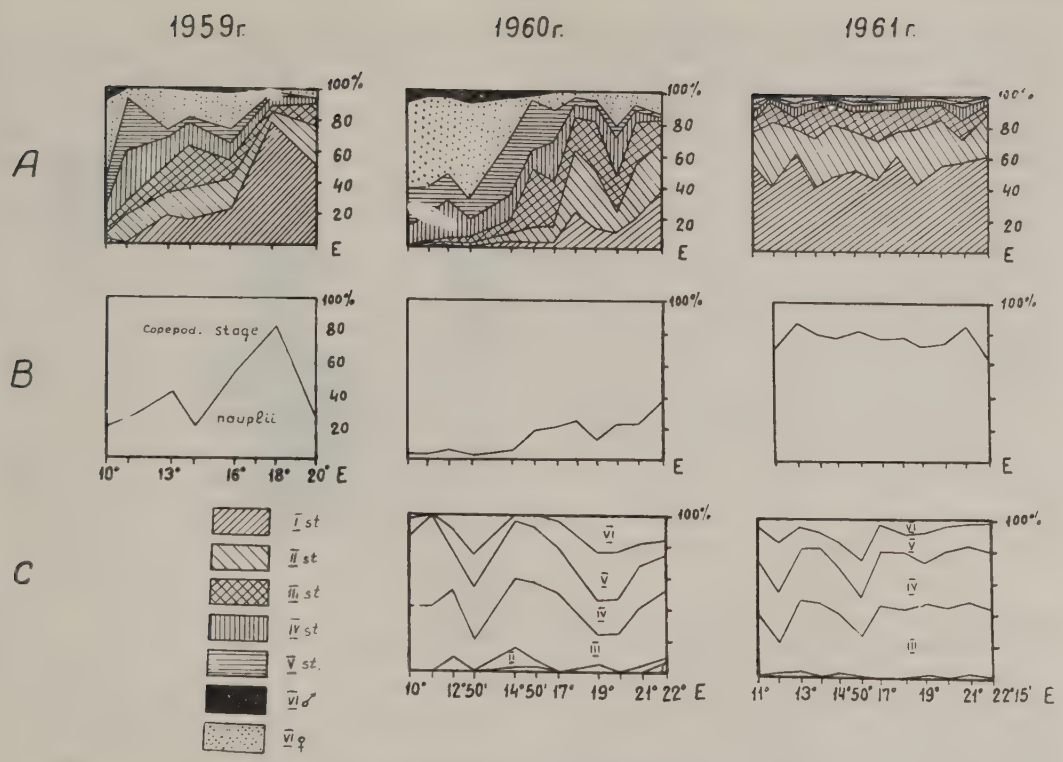


Figure 1. Age composition of the population of *Calanus finmarchicus* in the section along 71°10′N in the 50—0 m layer in April 1961.
A = Percentage copepodite stages in the different years.
B = Percentage copepodite and nauplii stages in the different years.
C = Percentage nauplii stages in the different years.

Sea the biomass of *C. finmarchicus* (copepodite stages III—IV—V) was rather low in June. *Aglantha digitale* made up a considerable portion of the plankton biomass.

In the same period, towards north in the area of Mohn's Threshold, the plankton was composed of *Calanus finmarchicus*, *Calanus hyperboreus*, *Metridia longa*, and *Themisto abyssorum*. In spite of the presence of large numbers of feeding organisms (more than 1000 mg/m³) no herring were recorded in the area of Mohn's Threshold, similar to the two previous years.

In May/June 1961 there were comparatively favourable conditions for the feeding of herring north of the Faroes, in the mixed waters near the boundaries of the East Icelandic Current, although the conditions were less favourable than in 1960 and differed but little from those of 1958 and 1959. The herring there fed upon *Calanus finmarchicus* (stages V—VI), young *Themisto*, and Euphausiacea.

Table 1. Average amount of plankton in the 50—0 m layer in June 1958/1961 in the herring feeding area in the mixed waters near the boundaries of the East Icelandic Current

Year	1958	1959	1960	1961
Number of stations	24	84	69	36
Average biomass (mg/m³)	480	510	952	460

In the Jan Mayen area the year 1961 was distinguished by a late production of plankton and an absence of the herring shoals which used to feed there during the summer.

The average plankton biomass for July 1958/1961 in the regions where herring feed in summer is shown in Table 1. The boundaries are the following: to the west, the section Langanes/Jan Mayen; to the east, 4°W Long; to the south, the section Faroes/Iceland; to the north, the section along 71°10′N.

It appears from Table 1 that the average plankton biomass was somewhat lower than in 1958 and

1959, and considerably lower than in 1960. In the latter year, in connection with a strong increase of the influx of warm waters along the western branch of the Norwegian Current, red *Calanus* (copepodite stages III—IV—V) appeared over wide areas of the south-western Norwegian Sea as early as June, and the average plankton biomass reached 952 mg/m³. The herring attained a high degree of fatness in June already (index 2.08), but in 1961 the highest fatness was reached in July (index 2.26), the same season as in 1959. Similar to 1959, the herring fed upon adult *Calanus* (stages IV—V—VI), young *Themisto* and euphausiids which were scarce that year.

The prolonged spawning of *Calanus finmarchicus* in the eastern areas of the Norwegian Sea (Fig. 1) in April and the late development in the Jan Mayen area and near the boundaries of the East Icelandic Current delayed the feeding of herring in 1961.

A. A. Degtyaryova,
E. A. Pavshtiks

Recherches sur la Biologie des Euphausiacés dans la Partie Sud de la Mer de Barenz

(Figure 2; Tableau 2)

Les recherches sur la biologie des Euphausiacés en Mer de Barenz, commencées en 1952, ont été poursuivies en 1961. La tâche principale de ces recherches est d'étudier le dynamique du stock des petits Crustacés d'Euphausiacé. Pour cela on pratique l'estimation des Euphausiacés dans la partie sud de la Mer de Barenz à l'époque d'automne et d'hiver de chaque année. Le matériel se récolte essentiellement par le filet à plancton lié à la corde de dos (gaze No. 0, diamètre de l'ouverture 50 cm), c'est-à-dire on capture le plancton dans la couche de l'eau près du fond. L'estimation hivernale donne la représentation de l'échelle future de la reproduction des Euphausiacés de l'année actuelle et de l'intensité des concentrations de post-pontes pendant l'été.

En ce qui concerne l'état du stock des Euphausiacés en Mer de Barenz, les données de plusieurs années

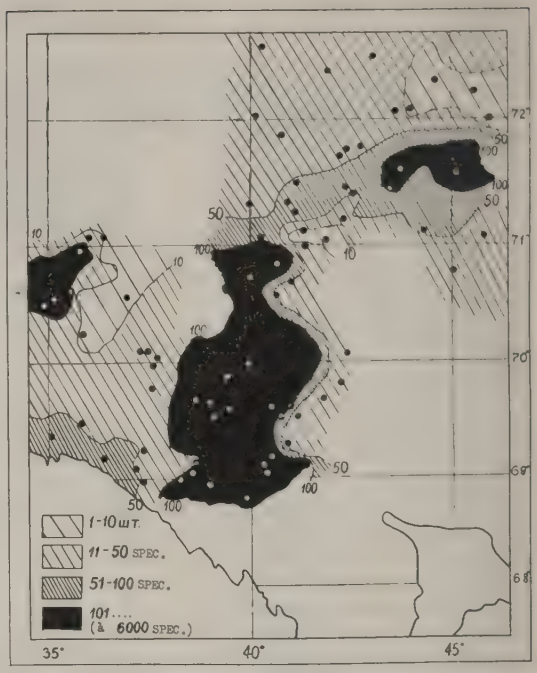


Figure 2. La distribution de *Thysanoessa inermis* et *T. raschii* (toutes les groupes d'âges) en hiver 1960/1961.

nous permettent de révéler les particularités de l'année.

Au debut de 1961 *Thysanoessa inermis* dominait dans presque toutes les régions (Tableau 2). Cette espèce était plus abondante le long de la branche principale du courant Nord Cap, et moins riche dans les régions orientales. D'après la signification *Thysanoessa raschii* était la deuxième espèce qui se trouvait essentiellement dans les basses eaux orientales.

La relation entre ces deux espèces dépend pour la plus part de la condition thermique de l'année précédente. Nous avons constaté que ces deux espèces, indiquées ci-dessus, sont des animaux arctique-boréales, mais *T. raschii* supporte mieux les changement plus brusques de température que

Tableau 2. Les pourcentages de *Thysanoessa raschii* et *Thysanoessa inermis* (adultes et jeunes) dans la partie sud de la Mer de Barenz en hiver 1960—1961

Espèce	Régions						
	Le banc Finnmark	La région littorale occidentale	Les basses eaux de Mourmane	Le banc d'Oie	La partie septentrionale des basses eaux de la Nouvelle-Zemble	La partie septentrionale de la région littorale orientale	La pente des basses eaux de Kanin-Kolguiev
T. inermis	98	86	57	73	51	30	33
T. raschii	2	5	39	19	42	70	66

T. inermis. C'est pourquoi le pourcentage éle véde *T.inermis* en 1961 correspond au contenu thermique considérable des eaux dans la partie sud de la Mer de Barenz en 1960. En comparaison avec les années précédentes le pourcentage de *T. raschii* en hiver 1960—61 était moins grand dans toutes les régions.

Le trait distinctif de l'année 1961 est le petit afflux de *Meganyctiphanes norvegica* et *Thysanoessa longicaudata*.

Le grand nombre des Euphausiacés en hiver 1960—61 habitait la région littorale orientale, les basses eaux de Mourmane (excepté la partie orientale) et la région centrale occidentale. A l'intérieur des régions indiquées il y a une vaste concentration détendue vers la direction méridienne. L'étendue méridienne de la riche concentration s'explique par le rapprochement des gradients températures de l'eau dans la partie sud de la Mer de Barenz et par la présence de la zone du »front polaire« vers le nord, le long de la section de Kharlov: vers l'ouest la température moyenne de l'eau dans la couche de 0—200 m était proche à celle-ci de l'année modérément chaude; vers l'est le contenue thermique des eaux correspondait à la condition relativement froide de l'année 1957. Cela a déterminé l'abondance de *T. inermis* et *T. raschii* à l'intérieur de la concentration indiquée. La capture par heure de chalutage est évaluée comme suit:—

La région littorale orientale:	
T. inermis	1488 spécimens
T. raschii	914 spécimens
Les basses eaux de Mourmane:	
T. inermis	882 spécimens
T. raschii	1038 spécimens

La quantité des Euphausiacés dans les régions situées vers l'est ou vers l'ouest de la concentration indiquée, était moins grande et se caractérisait par des captures moyennes pour la même période:—

La pente sud-occidentale du banc de Mourmane	322 spécimens
La région littorale occidentale	100 spécimens
Le banc d'Oie	93 spécimens

En 1961 les concentrations essentielles des Euphausiacés étaient plus occidentales et plus denses qu'en 1960. L'abondance des Euphausiacés était la même que dans l'année précédente.

Les jeunes Euphausiacés habitaient les mêmes régions que les adultes, mais les premiers étaient distribués plus largement et uniformément. C'est pourquoi dans les régions de grandes concentrations des Euphausiacés la proportion des jeunes était négligeable. Dans les régions de grande concentration la composition d'âge des Euphausiacés se caractérise par le grand pourcentage des jeunes *T. inermis* et par la prédominance des adultes *T. raschii*. La quantité du nombre de recrues de *T. raschii* est moins élevée qu'on pouvait attendre selon le stock des individus adultes. La prédominance des adultes sur les jeunes indique la dégression du stock de cette espèce à eau froide, évidemment lié à l'échauffement puissant d'été des eaux, de la Mer de Barenz en 1960. La population de *T. inermis* se trouvait dans des conditions plus favorables pendant les dernières trois années. Le taux des jeunes de cet espèce (par rapport aux adultes) était plus grand que chez *T. raschii*, non seulement dans les régions occidentales et centrales, mais aussi dans les régions orientales.

S. S. Drobicheva

Sebastes in Continuous Plankton Records in 1961

(Figures 3–5)

Plankton Recorder sampling in the oceanic areas of the North Atlantic was continued in 1961 on the standard routes previously operated, and was extended in June by the addition of a route between Liverpool and St. John's, Newfoundland ("D" route) and in July by routes from St. John's to Halifax, Nova Scotia ("Ea") and from Halifax to Boston, Mass., ("Eb")[1]. Extra sampling was carried out on the "Z" route (between Iceland and Newfoundland) and on weather ship routes to Ocean Weather Station "Alfa" (in 62°N Lat. 33°W Long.) in April and May to complement the joint Icelandic-German redfish survey cruises in May. In June and July sampling on the "Z" route was temporarily suspended, as a strike of dock labour in Reykjavik prevented the delivery of Plankton Recorders to the vessels normally towing on this route.

As in previous years, the young stages of the redfish were found in the areas south and south-west of Iceland, across the Irminger Sea, and from south-east to south of Cape Farewell, Greenland. With the exception of one large individual in August, they were all taken (as in previous years) during the period April to July. They all appeared to be of the *Sebastes marinus* type, none being noted as exhibiting any of the pigment or opercular spine development characteristics attributed to the *mentella* type or to *S. viviparus*.

[1] The "Ea" and "Eb" routes are sampled as part of a contract (62558—2834, NR 104—601) from the United States Office of Naval Research.

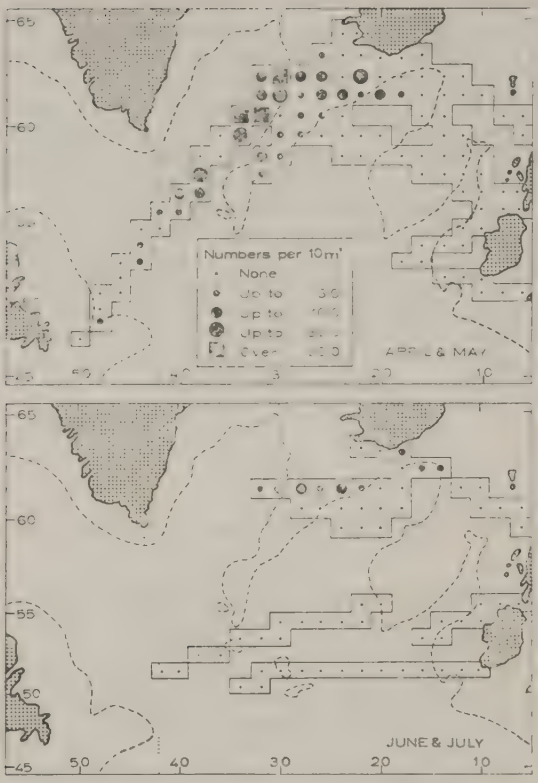


Figure 3. Charts showing the distribution, at 10 metres depth, of the young stages of the redfish, *Sebastes marinus*, in April and May, and in June and July, 1961. The eastern boundary of the ICNAF area is shown by a dotted line, and the 1000 fathom depth contour by a broken line.

The occurrences of these young stages were apparently a little later than in some of the preceding years, as none were taken before mid-April and only 5 in the second half of this month. They were, however, very abundant throughout May, reaching 38 per 10 m³ in the Irminger Sea; fair numbers were also taken across the Reykjanes Ridge in about Lat. 61°—62°N in June. Very few were taken in July, but the area in which catches have been most regular in this month in earlier years, south of Cape Farewell, was unfortunately not sampled. As in previous years the highest numbers were found to the west of the centre line of the Reykjanes Ridge. The overall abundance, south and south-west of Iceland in April and May, was 15% higher than the previous best year, 1959, and was over twice the mean level for the period 1955 to 1960; they were even more abundant in June than is usual in this month, but sampling was not adequate for a precise estimate. From a comparison between the Recorder material and preliminary results from other sources, it appears that there is a general agreement as to the broad pattern of larval redfish distribution in 1961. The distribution in Recorder samples at 10 metres is shown in Figure 3, where the samples for April and May and for June and July are combined into two charts.

The percentage size composition is shown, in Figure 4, with blacked-in histograms for the 1961 material superimposed on the open histograms representing the combined size frequencies for the 1955—60 period. There is some increase in the representation of the smallest sizes (6.0—7.9 mm) in May, suggesting, perhaps, that release of the young was later than usual; a suggestion borne out by the size-frequency distribution in June and by the late appearance of *Sebastes* in the Recorder samples (see above).

The first records on the "D" route did not extend beyond 42°W longitude and did not take any young redfish; but, on the first records between St. John's and Boston ("Ea" and "Eb"), a small number of young redfish were found in July and August. These specimens all had the sub-caudal melanophores stated to be characteristic of the *mentella* type, and were very much smaller than

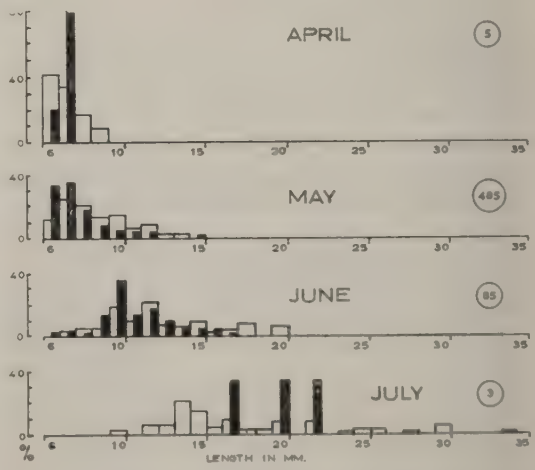


Figure 4. Histograms showing the percentage size composition, month by month, of the young stages of the redfish, *Sebastes marinus*, taken at 10 metres depth by the Plankton Recorder. Open histograms show the combined results from the years 1955—60 and the superimposed blacked-in histograms represent the 1961 results. The numbers taken in each month in 1961 are shown in circles at the right hand side.

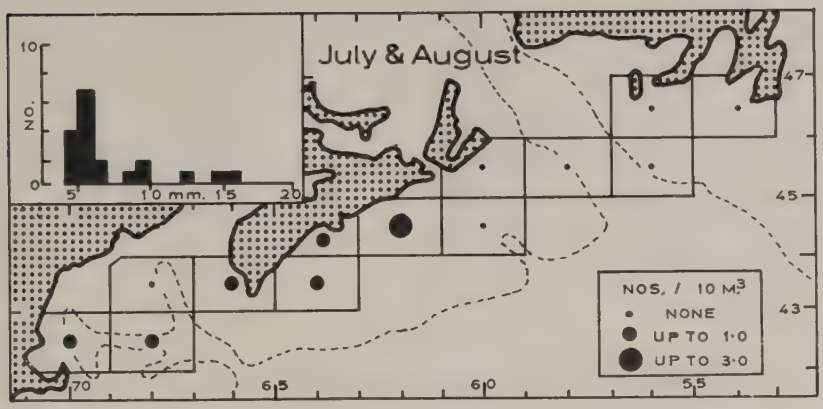


Figure 5. Chart showing the distribution, at 10 metres depth, of the young stages of the redfish, *Sebastes*, taken on July and August Recorder tows between Cape Race, Newfoundland, and Boston. The numerical size composition of the catches is shown inset, and the 100 fathom depth contour is indicated by a broken line.

those taken in these months in the open Atlantic where specimens with sub-caudal melanophores have never been found during 7 years of sampling with Plankton Recorders. Their distribution in July and August is shown separately in the chart in Figure 5, on which is also shown the size composition by numbers caught. These occurrences, from the later part of the season, cannot offer more than a fragment of the distribution pattern in this area, but it is hoped that sampling in 1962 will provide information throughout the season.

G. T. D. Henderson

Plankton Investigations from Aberdeen during 1960—1961

Phytoplankton

In the late autumn of 1960 very few diatoms were found in the Faroe-Shetland Channel but *Thalassiothrix nitzschioides* occurred at the entrance, associated with the dinoflagellate *Noctiluca* which is a rare visitor to these waters. The few stations sampled west of Faroe also contained *T. nitzschioides* with *Halosphaera* at the most westerly station (QQ 22). This apparent continuity of the flora from the Channel entrance to the west of Faroe was supported by the zooplankton distribution.

Rhizosolenia alata occurred in April 1961 in Faroe waters and extended halfway across to Shetland, this being an early occurrence of this normally late summer form.

In August there was poor phytoplankton in the Faroe-Shetland region but in the period September to October, water containing *T. longissima* and *Halosphaera* occurred as a central core, the tip of which reached Flugga, and the ciliate *Euphotes charon* was found at the entrance to the Channel. A few samples around Faroe indicated the presence of *Coscinodiscus* sp. whilst the water on the Scottish side of the core contained *R. alata* and this appeared to extend into the North Sea via the Fair Isle passage.

T. Lovegrove

Zooplankton

Plankton was sampled between Faroe and Shetland in April, August, and October and between Faroe and the Butt of Lewis in August and October.

In April *Calanus* was present in moderate numbers in the north-west but was very poorly represented near Shetland. Larval herring were abundant near Faroe, boreal plankton dominated the mid-channel area but there were some Atlantic species near Shetland, viz. *Agalma*, *Arachnactis*, and *Hippopodius*.

August sampling between the Butt of Lewis and Faroe Bank showed *Acartia* to be the dominant copepod with *Eucalanus* and *Rhincalanus* and also *Meganyctiphanes*, *Eukrohnia* and *Sagitta maxima*. South of the Wyville Thomson Ridge many siphonophores were found — *Lensia fowleri*, *L. multicristata*, *Praya dubia* (det. to be confirmed), *Rosacea cymbiformes*, *Vogtia spinosa*, *V. pentacantha* amongst other Lusitanian forms but although some of these were also found north of the Ridge they were in the minority. Between Faroe and Shetland plankton was still largely boreal oceanic towards the north-west but with a little Lusitanian at the south-east only.

Conditions had changed very little by October. Lusitanian plankton was still present at the south-west side of the Faroe Channel and open Atlantic species between the Wyville Thomson Ridge and Faroe Bank, where *Arachnactis* dominated the surface plankton, and *Solmaris*, *Thalassicolla* and *Collozoum* were found in the sub-surface layer. Plankton was very sparse in the deep water. Between Faroe and Shetland plankton was still boreal in nature over the north-western half, but with traces of the Lusitanian plankton near Shetland.

Thaliacea were very scarce in 1961, a few doliolids were found near the entrance to the Faroe Channel in August, and single specimens of *Salpa fusiformis* were taken over the shelf north of Scotland in November. Larval fish, *Paralepis*, *Stomias* and *Argyropelecus* were found with larval *Myctophum* in the October plankton south of the Wyville Thomson Ridge, and *Fierasfer* off the north of Scotland in November.

J. H. Fraser

B. Near Northern Seas

Plankton Investigations from Aberdeen during 1960—1961

(Figures 6–7)

Phytoplankton

In September 1960 *Halosphaera* occurred along the Scottish east coast, around the northern islands and extended about halfway across the northern North Sea. In this area *Rhizosolenia alata* was less abundant than elsewhere and a patch of *Acanthometron* was found. In general, higher values of faecal pellets and higher *Calanus* values occurred in areas where diatoms were low in number, indicating that grazing had taken place. *Halosphaera* persisted in the coastal areas in October and the numbers of diatoms remained low but by November and December *Halosphaera* was confined to offshore areas, and the coastal region contained *Ceratium tripos* and *C. macroceros*.

Samples taken in March 1961 showed *Skeletonema costatum* to be the dominant diatom from the Moray Firth to 3°E, and *Thalassiothrix nitzschioides* from 3°E to the Norwegian coast. The area east of Orkney linked up with the conditions prevailing west of Scotland at this time.

The most abundant diatom in the Shetland area in April was *Chaetoceros decipiens*, associated with *Globigerina*, but to the south and east of Shetland *Thalassiosira gravida* dominated with a further bloom of *C. decipiens* off the Scottish east coast. The remains of the March bloom of *S. costatum* lingered between the *Chaetoceros* and the *Th. gravida* blooms. Off the Norwegian coast there were few diatoms but large numbers of *Calanus*. Restricted sampling in May in the North Sea showed poor phytoplankton, mostly dinoflagellates, off the Scottish east coast, although in the northern part of the Irish Sea small numbers of the typically early spring forms — *Thalassiothrix nitzschioides* and *Coscinodiscus* sp. remained dominant.

In June, the phytoplankton, still mostly dinoflagellates, was sparse in the northern North Sea; *Ceratium minutum*, associated with the tintinnid *Parafavella elegans*, occurred off the Scottish and *C. longipes* off the Norwegian coasts. Between these two areas and around Shetland phytoplankton was very poor. July sampling in the Minch showed *C. convolutus* and *C. tripos* present in the north and *R. alata* in the south, while in the Moray Firth large numbers of *C. decipiens* were present.

The Faroe-Shetland area in August contained poor phytoplankton and was similar to the extreme northern part of the North Sea in June. From Kinnaird Head to Fladen *C. fusus* and *C. tripos* occurred with the tintinnids *Parafavella elegans* and *Ptychocylis minor*.

Water characterized by the presence of *R. alata* extended in September as a tongue from the Faroe-Shetland Channel through the Fair Isle passage to latitude of Kinnaird Head, and this water was also present to the north of Shetland where the silicoflagellate *Dictiocha fibula* occurred. To the west of this tongue *Nitzschia seriata* was dominant whilst dinoflagellates, *C. tripos*, were dominant near to the Scottish mainland with *R. styliformis* close inshore by Aberdeen.

Sampling in November off the west coast of Scotland showed that the area immediately around

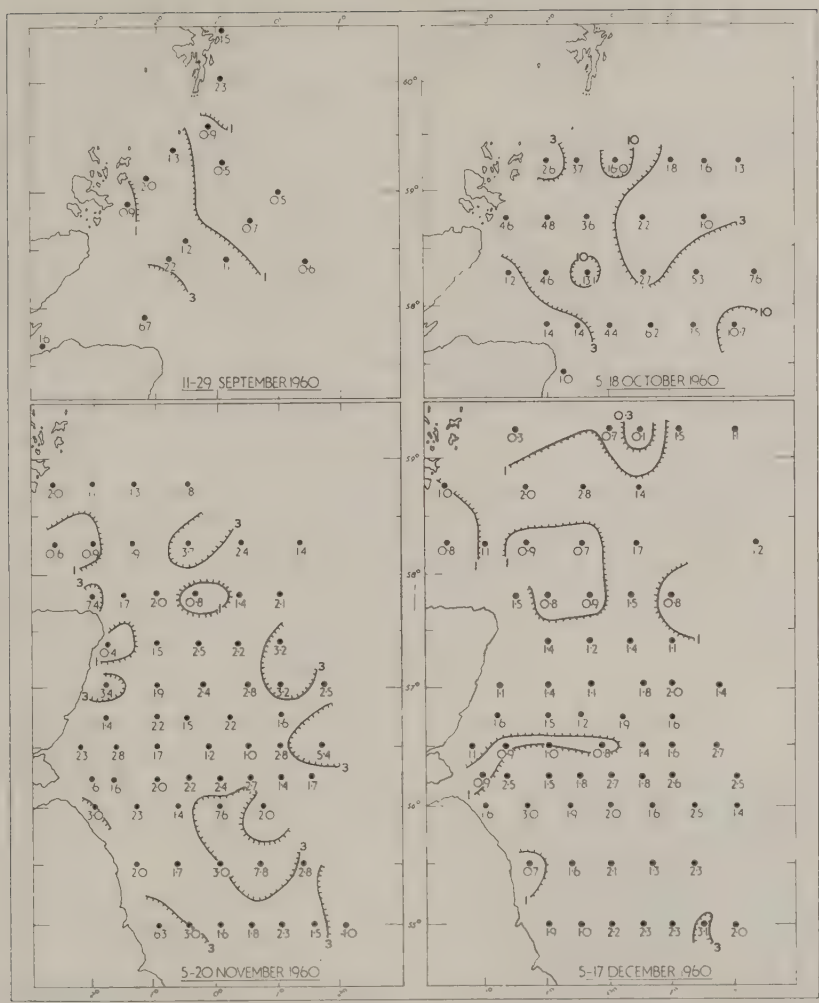


Figure 6. Standing crop of zooplankton September—December 1960, g/100 m³.

the Outer Hebrides was poor in diatoms, but with some *C. macroceros* which was replaced in more open water by *C. tripos*. *Halosphaera* occurred in all samples. In the more coastal waters approaching the Clyde diatoms such as *C. decipiens*, *Biddulphia sinensis* and *Coscinodiscus* sp. occurred but were dominated by *C. tripos*.

Restricted sampling in the North Sea at this time indicated an outburst of *T. nitzschioides* near the Scottish east coast and in the Moray Firth. Further offshore was a band of *Halosphaera* but otherwise negligible phytoplankton.

The general picture was similar to 1959—60 but there was more evidence of inflow of mixed water into the North Sea from the west. This occurred via the northern route in June and particularly through the Fair Isle passage in September.

T. Lovegrove

Zooplankton

The absence of any marked infow of oceanic water in the autumn of 1960 left static conditions of low productivity in the north-western North Sea in the spring of 1961. This was particularly noticeable in the resultant poor brood of *Calanus* to the north-east of Shetland and immediate east

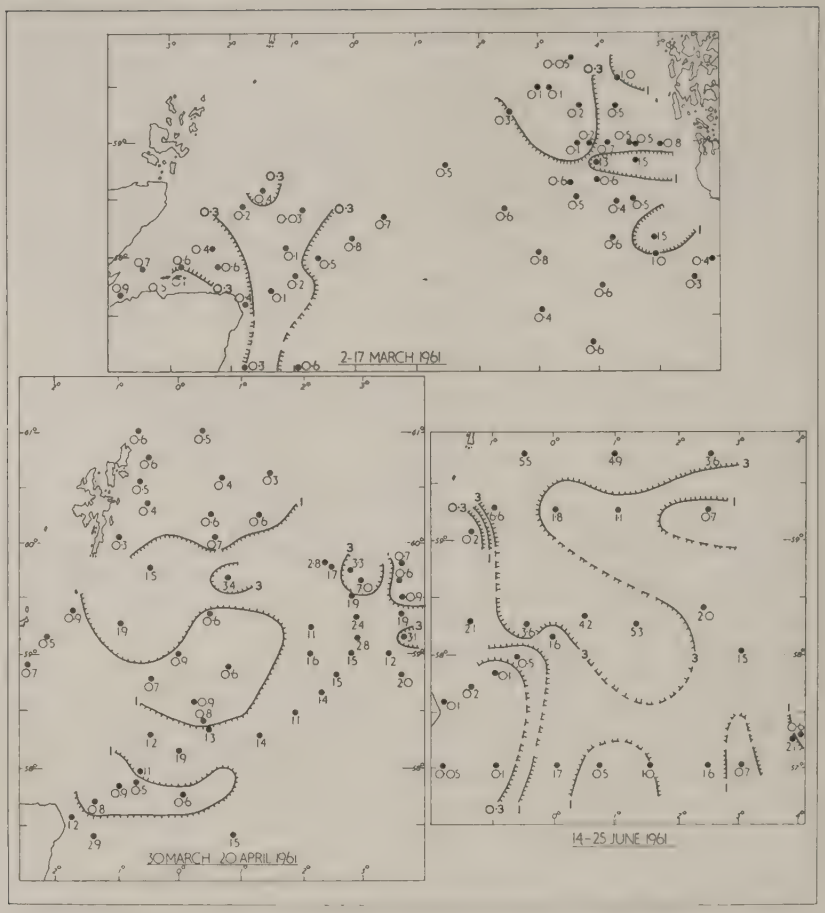


Figure 7. Standing crop of zooplankton March, April and June 1961, g/100 m³.

of Orkney and the Moray Firth in April, although east of 1°E conditions were normal. *Calanus* was still scarce in these areas in June, and the poor area had spread to cover all the east Shetland waters and most of the area between Shetland and the Moray Firth. It continued to spread southwards in July and *Calanus* was very sparse indeed in the Moray Firth. By August the area of poor *Calanus* had moved to the central North Sea area east of the Firth of Forth. *Calanus* was, by then, beginning to be abundant again in the region south of Fair Isle and was in general abundant in the northern North Sea in sub-surface waters in September.

This distribution of the area of poor *Calanus* is in part associated with the poor inflow of 1960 but is also in part dependent on the 1961 inflow of oceanic species. Their distribution indicated static conditions in the area of poor *Calanus* which was gradually moved by the incoming water mass. The oceanic species entering the northern North Sea via the north of Shetland were mainly east of 2°E and *Oikopleura* was particularly abundant there. South of Fair Isle the incoming fauna in June consisted mostly of small jellies, chiefly *Laodicea*, with some large adult *Spiratella* (= *Limacina*). These adults then gave rise to a new generation which flourished in September in the Fladen area. Between Fladen and the Scottish coast, however, the plankton of the incoming shelf water had changed and had a much larger proportion of oceanic species of a more southerly origin. *Cosmetira* had replaced *Laodicea*; phyllosoma larvae reached the Moray Firth; the radiolarians *Thalassi-*

colla and *Collozoum* reached the Aberdeenshire coastal area with *Arachnactes*, *Solmaris*, *Cosmetira*, and other oceanic species.

By October the area of poor *Calanus* had reached the Danish coast where the medusa *Phialidium* dominated the plankton.

The zooplankton of the Near Northern Seas area west of Scotland showed a changing sequence of events.

From March to June the area north of Ireland, west of 7°W, to the southern end of the Hebrides contained oceanic plankton including *Velella*, *Sagitta serratodentata*, *Anchialina*, *Rhincalanus* and *Eucalanus*, but *Calanus* was abundant east of 7°W and nearer inshore, and on the shelf generally, together with decapod larvae, pteropods and young fish. *Calanus* was particularly abundant both north and south of the Minch. Evidence for an outflow from the Irish Sea is given by the presence of *Sagitta setosa* off Rathlin Island and the Mull of Kintyre.

As the year continued the Lusitanian proportion of the plankton increased progressively northwards to be in abundance west of the Hebrides and at the entrance to the Faroe Channel in August and September, although only a fraction reached the Shetland end of the Channel. (See report to Distant Northern Seas.) By November this fauna had mostly left the area north of Ireland and west of Scotland except for the siphonophore *Sulculeolaria biloba* which is usually found throughout the winter. A few *Salpa fusiformis* and larvae of *Fierasfer* were found on the shelf north of Scotland in November.

J. H. Fraser

The standing crop of zooplankton (Figs. 6 and 7)

The areas surveyed and the results available are shown in Figure 6 for 1960 and Figure 7 for 1961. The figures give the dry weight of zooplankton in grammes per 100 cubic metres, the calculations being based on the duration of the haul in all 1960 samples, while in most of the 1961 samples the calculations are based on Currie and Foxton depth-flowmeter readings. The two methods give roughly comparable results.

The samples on which the results are based were collected with the Gulf III high speed sampler, fitted with a net of mean mesh size 0.231 mm, and towed obliquely from near bottom to surface. The samples were preserved as described by Lovegrove (Rapp. Cons. Explor. Mer, **153**: 86–91) and dried in an oven at 60°C for 24 hours after all larval fish had been removed. In 1960 weighing bottles were used but in 1961 glass rings with a base of silk netting were used. The efficiency of those methods are described by Lovegrove (loc. cit.).

J. A. Adams

The Continuous Plankton Recorder Survey: Plankton around the British Isles during 1961

(Figures 8–19)

In 1961, the Plankton Recorder Survey was continued on a similar scale to that of previous years but with extensions into the western Atlantic. Samples were collected at monthly intervals at the standard depth of 10 m in the North Sea and, in the North Atlantic, within the area bounded by the coasts of Massachusetts, Newfoundland, Iceland, Norway, and Portugal. As in previous volumes of *Annales Biologiques*, this present report is restricted to the results from the area around the British Isles shown in Figure 8. A brief account of the distribution of planktonic stages of *Sebastes* in the western North Atlantic is provided by Henderson (p. 63 of this volume).

The report for 1960 introduced a new method of presenting the results (Glover, Colebrook and

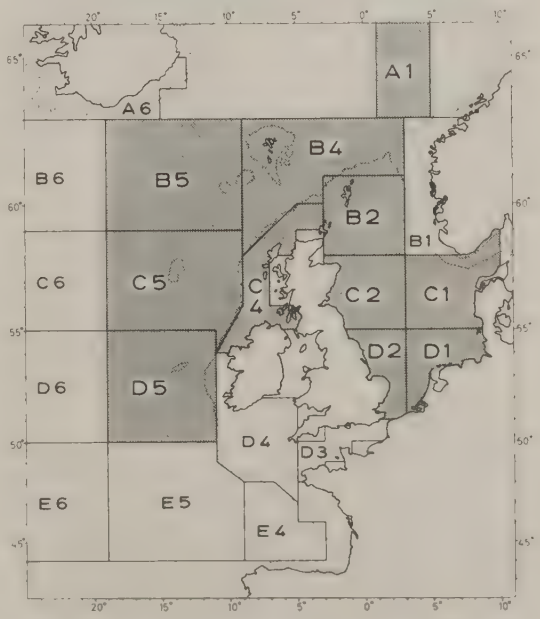


Figure 8. A chart showing the area sampled by Continuous Plankton Recorders during 1961. The area has been divided into sub-areas (see text). The stippled sub-areas have been sampled regularly since 1948 and are the basis of the results presented in Figures 9—12 and 14—19.

ROBINSON, 1962, Ann. Biol., **17**: 85—89). This method is used again in the present report. The area has been divided into the sub-areas shown in Figure 8; these were designed to assist comparisons of Plankton Recorder collections with fishery statistics and hydrographic data. For each month, in each sub-area, the mean number per Recorder sample has been calculated for all the common species of plankton. The results for a selected few of these are shown in Figures 9—12 and 14—19 where histograms show the data for 1961. In order to provide a measure of the "normal" seasonal cycle of each organism, long-period means have been calculated for each month in each sub-area. They were obtained by combining all the results from Plankton Recorder collections in the period 1948—1959. These twelve-year means are shown as line-graphs in the figures. The annual and long-period means are calculated from logarithmic transformations of the original counts.

Results for sub-areas A6, B6, D4, and E5 have been omitted because sampling was available from them for only a part of the year. Results from D3 and E4 have been excluded because these sub-areas have been sampled by Recorders since 1957 only and long-period means cannot, therefore, be calculated. Results from B1 are omitted because sampling is limited to the extreme north and south of this sub-area. Results from sub-areas B4 and B5 are combined. Detailed results from all the areas including the central and western North Atlantic, and for species not illustrated here, will be supplied on application to the Oceanographic Laboratory, Craighall Road, Edinburgh, 6, Scotland.

The graphs and histograms are arranged in two groups in the figures which follow. Firstly, the oceanic areas, representing sampling over deep water from the most southerly (D5) to the most northerly (A1). Secondly, and separated in the figures from the oceanic group by a heavy line, the results from the Atlantic shelf and the North Sea, arranged in a sequence, counter clockwise around the British Isles, from C4 to D1.

The intensity of the green colour of the Recorder silks is assessed visually in four categories which are transformed to a numerical scale based on comparisons of acetone extracts of standard Recorder samples. This provides a rough estimate of total phytoplankton. The results, plotted in Figure 9, show that phytoplankton was less abundant than usual in the spring over the deep oceanic Atlantic (D5, C5, B4 and 5). In the autumn the crop was close to or above normal; for example, in C5 where *Ceratium lineatum*, *C. furca* and *C. fusus* in August and *C. fusus* and *Rhizosolenia alata* var. *indica* in

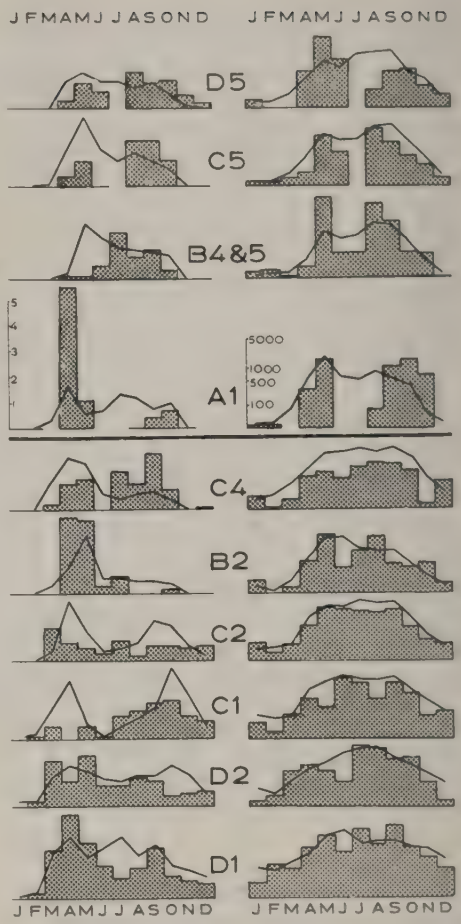


Figure 9. (left). Histograms showing a month-by-month estimate of the phytoplankton during 1961, based on visual assessments of the green colour of the Recorder silks. The letters and numbers (D5, etc.) refer to the sub-areas shown stippled in Figure 8. The line graph shows the long-period mean value based on a combination of all Records in each sub-area in the period 1948—1959. A break in the base-line indicates that there was no sampling in that month. For further details, see text.

Figure 10. (right). Histograms showing the average number, per Recorder sample, of Total Copepods during 1961. A Recorder sample represents the plankton in about 3 m^3 of water. For further details, see text and Figures 8 and 9.

September were especially abundant. In the remaining oceanic area (A1, off the Norwegian coast), the sequence was reversed, with unusually abundant phytoplankton in the spring and a scarcity in the autumn. The rich phytoplankton in this area in April contained *Thalassiosira* spp.,

Chaetoceros spp., *Nitzschia seriata*, and *Rhizosolenia hebetata* var. *semispina*.

In the North Sea and the Atlantic coastal waters the spring outburst, as usual, was earlier than in the oceanic regions of the Atlantic. Off the west of Scotland and in the central North Sea it was about one month earlier (in March) but in the south-eastern North Sea it was two months earlier (in February). Off the Scottish west coast (C4), as in the neighbouring oceanic areas, there was an unusually poor crop of phytoplantkton in the spring and a rich one in the autumn when *Ceratium horridum* was extremely abundant with *Rhizosolenia alata* var. *indica* and *R. alata* var. *alata*. In the north-western North Sea (B2), as in the Norwegian Sea (A1), there was a rich spring crop and a poor autumnal one. In the spring *Thalassiosira* spp. were especially abundant, and appeared earlier than usual. Elsewhere in the North Sea phytoplankton was less abundant than usual although there was a fairly rich crop of *Nitzschia delicatissima* associated with *Phaeocystis* in the south-east (D1) in April.

In general, phytoplankton was more scarce than usual over the whole area of the survey with the exception of the spring outbreaks in the Norwegian Sea (A1) and the north-western North Sea (B2). As in 1959, *Thalassiothrix longissima* was present in the North Sea in very low numbers (it was absent in 1960). It continued its negative association with the copepod *Corycaeus anglicus* which was very abundant in the eastern and southern North Sea, as it was in 1959 and 1960. The scarcity of phytoplankton in the North Sea was largely attributable to the exceptionally low numbers of *Chaetoceros* spp. Two unusual discoveries were made. *Biddulphia sinensis* occurred, in low numbers, in area D5 in October and December; so far as we know this is the first time this diatom has been found in the oceanic waters of the Atlantic. *Rhizosolenia acuminata*, which had never been found in the Recorder survey before 1959, was widespread in the Atlantic areas D5, C5, B4 and 5, and A1).

The numbers of Total Copepods (Figure 10) were a little below average in most areas except the southern North Sea where they were close to normal. In May, however, there were high numbers of copepods in the oceanic Atlantic (D5, C5, B4 and 5) when *Acartia clausi* was more abundant than it had ever been since 1948. In the autumn, as in 1960, copepods (mostly *Acartia*) were abundant in the Norwegian Sea (A1). The relative scarcity of copepods was most marked in the coastal Atlantic area C4 where the numbers were below average from January to November. *Calanus finmarchicus* (Figures 11 and 12) was particularly scarce in this area and in the oceanic areas D5

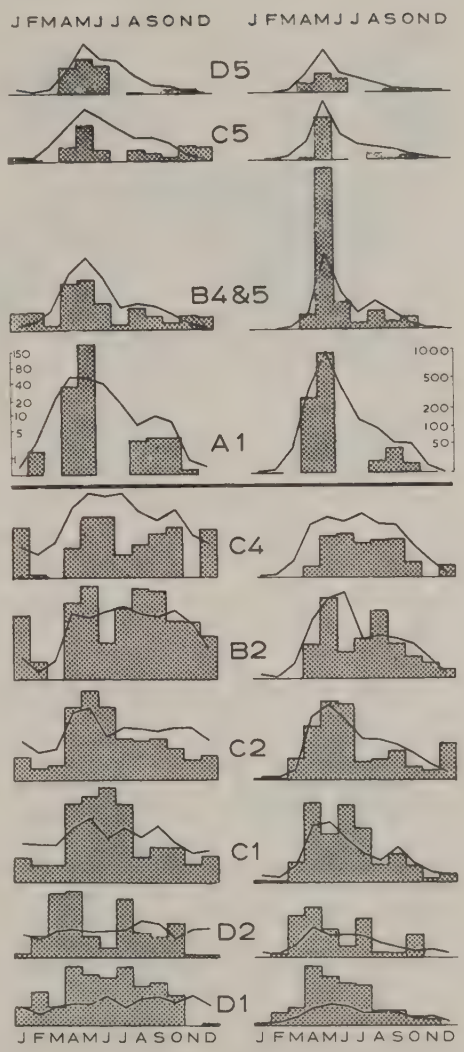


Figure 11. (left). Histograms showing the average number, per Recorder sample, of copepodite stages V and VI of *Calanus finmarchicus* during 1961. The *finmarchicus* and *helgolandicus* forms are combined in this illustration and in Figures 12 and 13. For further details, see text and Figures 8 and 9.

Figure 12. (right). Histograms showing the average number, per Recorder sample, of all stages of *Calanus finmarchicus* during 1961. For further details, see text and Figures 8 and 9.

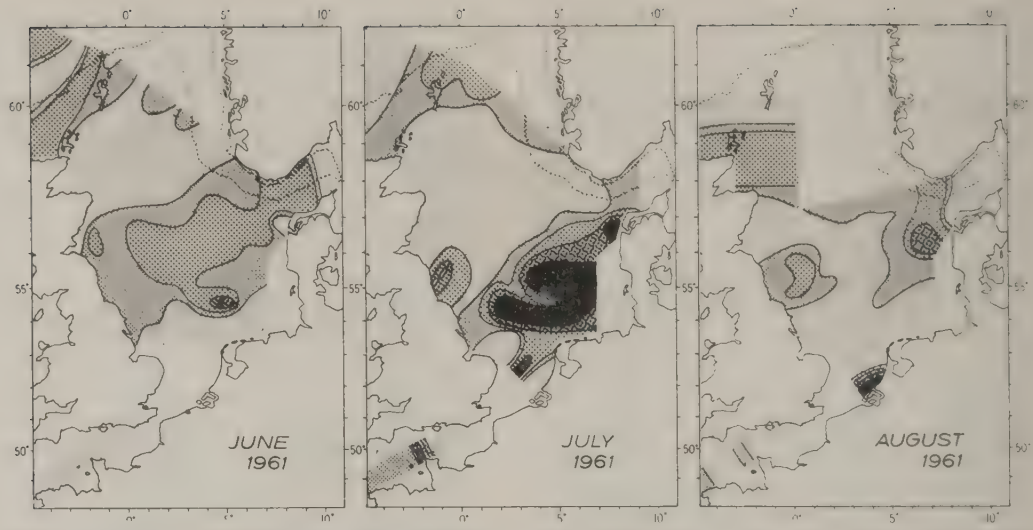


Figure 13. Anomaly distribution of *Calanus finmarchicus* during three months of 1961. The numbers on the Plankton Records in these months were expressed as a percentage of the average number for the period 1948—1960 in each statistical square (2° Lat. × 1° Long.) in each of the months June, July, and August. See text for further details. The blank areas were not sampled. The lightly stippled area represents values of 0—75%; subsequent contours are drawn at 150%, 300%, and 500%.

and C5 (as it was also in 1960). In the remaining oceanic areas (A1, B4 and B5) it was below the average abundance except in May and, except in May and August, in the north-western North Sea (B2). In the central and south-western North Sea it was closer to the long-period average but in the German Bight (D1) it was unusually abundant, being above the average numbers from February to October. In general, the scarcity of *Calanus* was more marked in copepodite stages I—IV than in the adults and stage V. The histograms for the sub-areas, in Figures 11 and 12, do not reveal clearly the pattern of distribution of *Calanus* in the North Sea. This is shown, for three months, in Figure 13 where the distributions are plotted as percentage anomalies. The counts for each 10-mile Recorder sample are expressed as percentages of the average number in each statistical square (2° Lat. by 1° Long.) for each calendar month during the years 1948—1960. By plotting anomalies of this kind, each sample is related to the "normal" level of abundance for the area and month in which it occurred. In June 1961, *Calanus* was very scarce in the north-western North Sea (and in the south). In July the area of scarcity had extended further southwards and eastwards; at this time the numbers in the German Bight were from 5 to 10 times greater than the long-period average for this area in this month. In August the area of low numbers spread even further south and the concentration in the German Bight disappeared dramatically. In August, also, numbers increased in the north-western North Sea. The scarcity of *Calanus* in mid-summer was very striking; it was entirely absent from the Aberdeen/Lerwick area in June, very scarce indeed on the Leith/Copenhagen Record in July and absent from the southern ends of the Hull/Copenhagen and Leith/Rotterdam and Bremen Records in August.

A number of the other copepods, like *Calanus*, were scarce in the Atlantic and the northern North Sea but close to or above their average abundance in the German Bight. *Pseudocalanus elongatus* is the most striking example. It was more scarce than it has ever been during the last fifteen years in the Atlantic areas D5, C5, and C4; its numbers were very low in B4 and B5, and rather low in the northern and central North Sea (B2, C2, and C1); in the Southern Bight (D2) it was close to the long-period average and only in the German Bight was it above the average abundance. *Centropages typicus* showed a similar trend; it was very scarce in the Atlantic, absent (most unusually) throughout the year in the north-western North Sea (B2), scarce in the west-central North Sea (C2), close to the average in the east-central region (C1) and the Southern Bight (D2) but much more abundant than usual in the German Bight (D1).

WILLIAMSON (p. 79 of this volume) describes the unusual scarcity of almost all species of plankton except *Acartia clausi* in the area fished by the drift-net vessels from Fraserburgh. Indeed, if it had not been for the relative abundance of *Acartia* (Figure 14), the paucity of the copepod plankton in 1961 would have been very striking indeed. *Acartia* showed the reverse of the geographical trend exhibited by *Calanus* and the other copepods mentioned above. It was abundant in the Atlantic and the northern North Sea (where *Calanus* was scarce) and well below the average in the German Bight (where *Calanus* was abundant). *Metridia lucens* (Figure 15) was another copepod which was abundant in the northern and west-central North Sea (B2 and C2) but elsewhere it was seldom numerous except in the Norwegian Sea at the end of the year, as in 1960.

Between 1953 and 1955 the gastropods, *Spiratella retroversa* and *Clione limacina* became progressively scarcer in the Atlantic and more abundant in the North Sea. This change was maintained in the following years and was again evident in 1961 (Figures 16 and 17) but both species were later than usual in the North Sea and their abundance there was not so marked as in recent years. Both of them reflected the general scarcity of plankton in the early summer in the north-western North Sea (B2) where they had been particularly abundant in 1960.

One of the most striking features of the plankton in 1960 was the appearance of the pteropod *Pneumodermopsis paucidens* over the continental shelf and in the north-western North Sea where it had never been found previously in Recorder samples; see COOPER and FORSYTH (1961, Nature, London, **191**: 1412). In 1961, *Pneumodermopsis* appeared again but in larger numbers and, whereas in 1960 it was restricted to areas C4, B2 and C2, in 1961 (Figure 18) it was found in these areas and in C1 and D2 in the central and southern North Sea.

With the exception of *Doliolum nationalis*, in the Celtic Sea in October, all the Thaliacea were found over deep water in the Atlantic west of the British Isles. *Dolioletta* (*Doliolum*) *gegenbauri* (Figure 19) was less abundant than usual and did not penetrate as far north, into areas B4 and 5, where it has sometimes been found in previous years. *Salpa fusiformis* was exceptionally scarce and found only south of Lat. 52°N (in most previous years it had penetrated as far as 60°N and in 1955 as far as 65°N). *Thalia* (*Salpa*) *democratica* also was rare and found only south of 48°N. As in 1960, *Ihlea asymmetrica* was not found in Recorder samples.

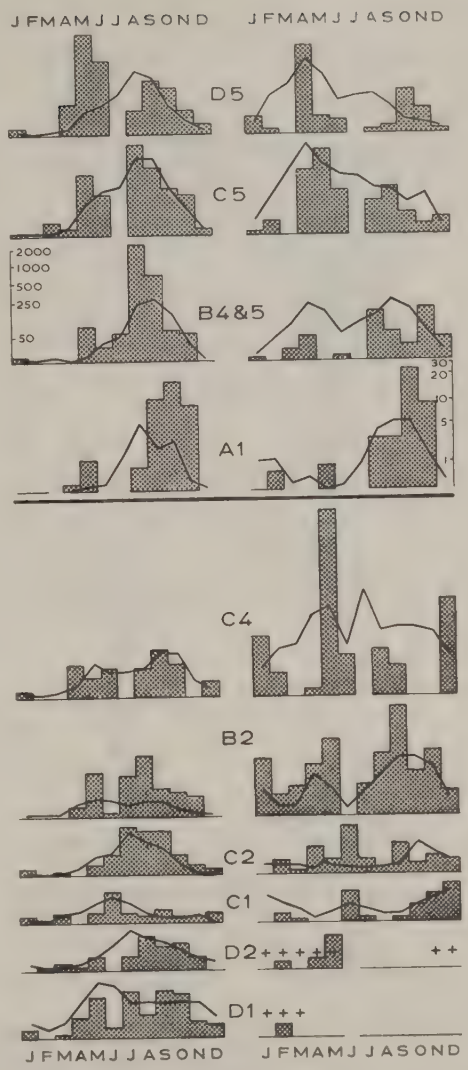


Figure 14. (left). Histograms showing the average number, per Recorder sample, of *Acartia clausi* during 1961. For further details, see text and Figures 8 and 9.

Figure 15. (right). Histograms showing the average number, per Recorder sample, of *Metridia lucens* during 1961; based on samples taken by night. Crosses indicate months and areas in which *Metridia* occurred in small numbers during the period 1948—1959. For further details, see text and Figures 8 and 9.

Many of the characteristic features of the plankton in 1961 were apparent also in 1960, but in a less extreme form; for example, the scarcity of phytoplankton and copepods (except *Acartia*) and the

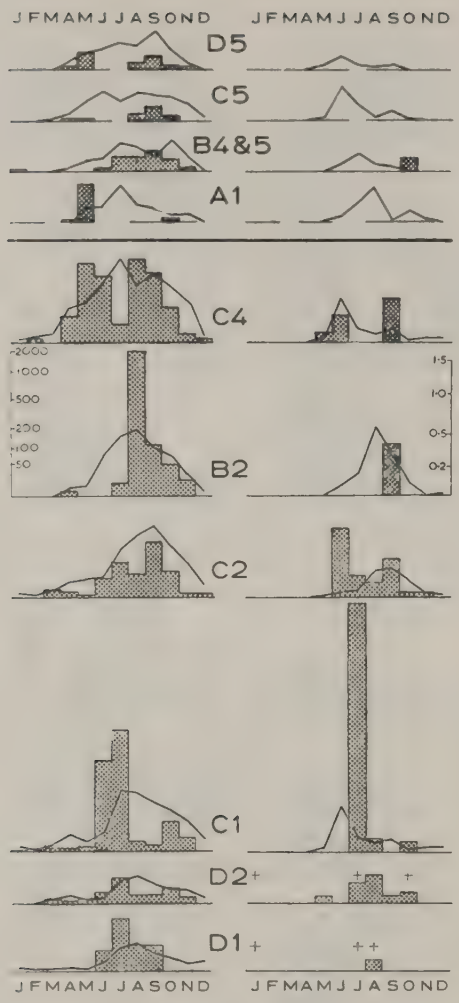


Figure 16. (left). Histograms showing the average number, per Recorder sample, of *Spiratella* (*Limacina*) *retroversa* during 1961. For further details, see text and Figures 8 and 9.

Figure 17. (right.) Histograms showing the average number, per Recorder sample, of *Clione limacina* during 1961. Crosses indicate months and areas in which *Clione* occurred in small numbers during the period 1948—1959. For further details, see text and Figures 8 and 9.

appearance of *Pneumodermopsis*. The same geographical trends were apparent in both years, but more strikingly so in 1961; for example, the relative scarcity of such organisms as *Calanus* and *Pseudocalanus* in the Atlantic and the northern North Sea with their relative abundance in the southern North Sea and the German Bight. The reverse gradient around the British Isles was shown in both years by *Acartia clausi*. As in previous years, there were many similarities between the plankton over the continental shelf west of Scotland (C4) and in the north-western North Sea (B2). In 1959 and 1960, however, the plankton of area B2 included such coastal-oceanic forms as *Eucalanus crassus*, *Euchaeta hebes*, *Pleuromamma borealis*, and *Centropages typicus*; in 1961 these species were absent from the north-western North Sea and other species of this kind, such as *Rhincalanus nasutus* and *Candacia armata* were unusually scarce. There was no evidence, from the plankton, of oceanic incursion into the northern North Sea in 1961.

R. S. Glover, J. M. Colebrook,
and G. A. Robinson

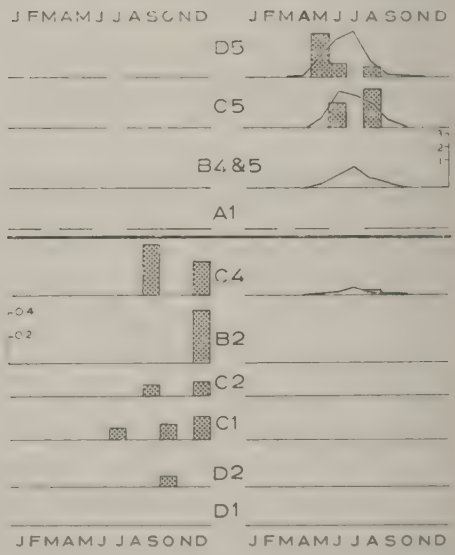


Figure 18. (left). Histograms showing the average number, per Recorder sample, of *Pneumodermopsis paucidens* during 1961. The graph showing the long-period mean is omitted because *Pneumodermopsis* was so rare in previous years. For further details, see text and Figure 8.

Figure 19. (right). Histograms showing the average number, per Recorder sample, of *Dolioletta* (*Doliolum*) *gegenbauri* during 1961. For further details, see text and Figures 8 and 9.

Plankton of the Buchan Herring Grounds in the Summer of 1961

(Figures 20–21)

The survey of the plankton of a standard area off the Scottish north-east coast (Figure 20), using small Plankton Indicators sampling at 8 m, continued in 1961. The sampling and analysis have been done in a standard way since 1949, and averages for the period June, July, and the first half of August were calculated for 23 planktonic entities. These entities are mostly species, some are groups of related species, and *Calanus finmarchicus* is counted as two entities, namely, copepodite stages I—IV and stages V and VI. The area and period cover the pre-spawning phase of the Buchan herring fishery. Further details of the analysis, a list of the entities, and their averages in each year from 1949 to 1959 are given in WILLIAMSON, 1961, Bull. Mar. Ecol., **5**: 207—22.

The summer of 1961 was remarkable for the scarcity of most of the planktonic entities. Nineteen of the twenty-three were below their average

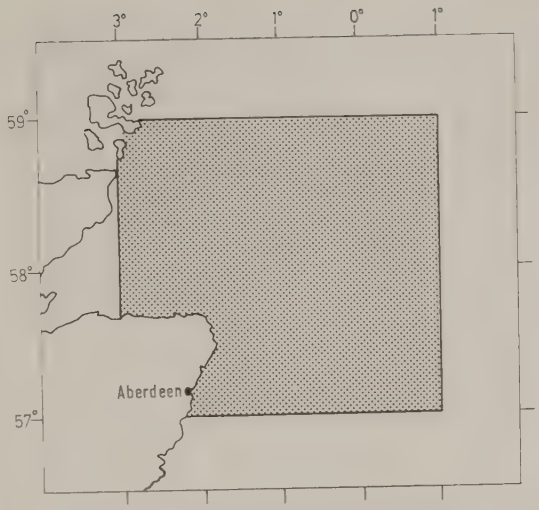


Figure 20. A chart showing the standard area of the small Plankton Indicator survey, off the north-east coast of Scotland.

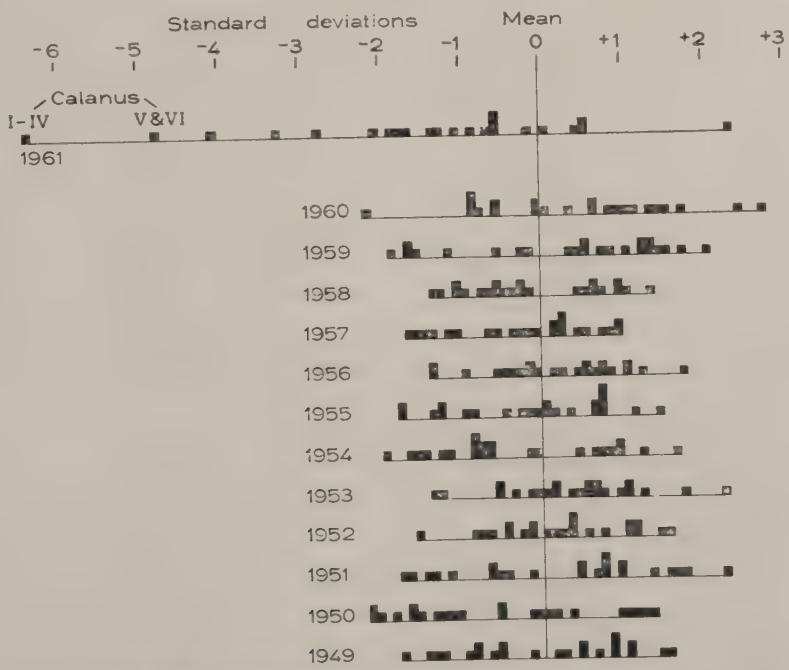


Figure 21. A histogram showing the abundance of each of 23 planktonic entities in the summer of each year from 1949 to 1961. The abundance of each entity is measured by the mean and standard deviation of the logarithms of its own abundance in the period 1949 to 1959.

abundance for 1949—1959, and nine were as scarce or scarcer than ever before during this survey. All stages of *Calanus* were particularly scarce: this is considered more fully by GLOVER, COLEBROOK and ROBINSON (pp. 73–78 of this volume). Figure 21 shows that *Calanus* was the extreme member of a series. This figure was constructed as follows. For each entity the mean and standard deviation was calculated of the logarithms of its averages in 1949—1959. Each average was then rescaled in standard deviations from the mean for that entity, and the rescaled values plotted. As there are 23 entities, there are 23 squares on each line of Figure 21. This method shows the abundance of the plankton in relation to the abundance in other years. For instance, 1950 was on the whole a poor year, 1959 a good one. The square at the right hand end of the 1961 line represents *Acartia clausi*, which was more abundant than it had ever been before. It was also, for the first time, the most abundant zooplankton species. With this one exception, the summer of 1961 in this area was an outstandingly poor one for plankton.

M. H. WILLIAMSON

C. Baltic-Belt Seas

The Vertical and Horizontal Distribution of Phytoplankton in the Southern Baltic in 1956

Investigations on the phytoplankton were carried out in March, May, June, August, and November in the following regions of the southern Baltic: Arkona Deep, Bornholm Deep, Slupsk Furrow, and Gdansk Deep.

The horizontal distribution was investigated in the surface layer between 0 and 15 m, the vertical distribution in the whole water column from surface to bottom.

The vertical distribution

In all the regions of the southern Baltic Schizophyceae dominate in the surface layer. The most abundant species are: *Aphanizomenon flos-aquae* (L.) Ralfs, *Nodularia spumigena* Mertens, *Microcystis aeruginosa* Kützing. The less numerous species are: *Aphanocapsa pulchra* (Kütz.) Rabenhorst, *Aphanotheca clathrata* W. & G. S. West, and the species *Chroococcus* Näg.

The peak development of Schizophyceae occurs in August and September; the blooming is noted in this period. The variation in abundance of certain species depends upon the region where it has been observed. It may generally be stated that the composition of phytoplankton species in the Arkona and Bornholm Deeps is very similar and indicate the presence of species typical for the northern seas, whereas the composition of the flora in the Slupsk Furrow is similar to that of Gdansk Deep. This holds good not only for the Schizophyceae species but also for other species present there.

Another group of phytoplankton encountered in abundant numbers in the surface layer are the Bacillariophyceae with *Thalassiosira*, *Sceletonema*, *Achnantches*, *Actinocyclus*, and *Chaetoceros*. Specimens of *Rhizosolenia*, *Melosira*, *Diatomea*, *Fragillaria*, *Cyclotella*, *Navicula*, and *Dipploneis* appear less numerously.

The peak development of Bacillariophyceae is observed in the regions of the Arkona and Bornholm Deeps, i.e. in the regions influenced by the inflowing North Sea waters during March, May, and June. In the regions of Slupsk Furrow and Gdansk Deep, however, the period of inflow occurs in June, September, and even November.

The third group of phytoplankton appearing in the surface layer is the dinoflagellates. They are *Peridinium*, *Ceratium*, *Dinophysis*, and *Dinobrion*. The number of species encountered is different in the various regions in the vegetation season investigated. The maximum development in Arkona Deep was noted in May and August, in Bornholm Deep in June, in Slupsk Furrow in June, and in Gdansk Deep in October.

The horizontal distribution

Schizophyceae appear in all the water layers from bottom to surface in all the regions investigated. It is most abundant in the surface layer between 0 and 15 m, but is quite plentiful at a depth of 70 m. Below 70 m the occurrence of this species decreases and only in Gdansk Bay is it found frequently at a depth of 90 m. Bacillariophyceae is most abundant in the 0—30 m layer; it appears quite numerously at a depth down to 70 m in the region of Slupsk Furrow and in Gdansk Deep but is found only sporadically below this depth.

Dinoflagellates are quite common in the regions investigated. In the blooming period they descend to a depth of 50 m, but in the remaining periods they are found in the surface layer.

One more group should be mentioned, the Chlorophyceae. This type of plant appears only sporadically in the surface layer. The species found are *Scenedesmus*, *Pediastrum*, *Ankistrodesmus*, *Oocystis* and *Trochiscia*. They were of no great importance in the period investigated.

Z. Ringer

Quantitative Characteristics of the Zooplankton in the Central Baltic and the Gulf of Riga

(Tables 3–4)

Quantitative zooplankton investigations were conducted at standard stations in the central Baltic (Klaipeda to the Gulf of Finland) in February, May, August, and October/November. In the Gulf of Riga, samples were taken every month except December. The gear used was a closing Juday net with a mouth area of 0.1 m² made of gauze No. 38 (38 apertures per 1 cm²). Depths of hauls made in the Baltic were: 0—10 m, 10—25 m, 25—50 m, 50—100 m, and 100—150 m; those in the Gulf of Riga were: 0—10 m, 10—20 m, 20 to 30 m, etc. down to the bottom.

For the macroplankton investigations an ichthyoplankton net was used with a mouth area of 0.5 m², made of gauze No. 12. For the microplankton assessment the samples were taken with a one-litre bottle and the calculations were made by the sedimentation method.

The main results of the assessment of the zooplankton abundance and biomass (Crustacea) obtained by means of the closing net are presented in Tables 3 (central Baltic) and 4 (Gulf of Riga).

During the winter (February 1961) a greater depletion in zooplankton abundance than usual was noted in the central Baltic and the Gulf of Riga. The average values of abundance and biomass were less than in all other years, except the winter of 1953. A steep decrease in the amount of zooplankton has been a characteristic feature of all

Table 3. Quantitative values of zooplankton (Crustacea) of the central Baltic

Date	Depth of hauls (m) 0–25 m		25–50 m		50–100 m		0–100 m		Number of years of observation
	1961	1949–61	1961	1949–61	1961	1949–61	1961	1949–61	
	Number of individuals per m³								
15.–26. February	2,020	2,200	790	1,090	490	680	950	1,160	6
12.–19. May	9,540	10,930	4,870	4,050	2,630	2,800	4,920	4,880	9 (8)
13.–19. August	18,590	17,770	10,600	7,370	4,280	4,100	9,440	8,330	8
30. Oct./2. Nov.	7,800	8,360	7,150	5,130	4,960	3,480	6,220	5,110	8
	Biomass (mg/m³)								
February	71	86	29	46	22	34	35	50	5
May	68	71	33	35	46	48	48	49	9 (8)
August	319	275	251	196	139	135	212	185	8
October	112	128	115	112	133	126	123	123	7

Table 4. Average long-term values of abundance of planktonic crustaceans (ind. m³) and biomass (mg/m³) in the Gulf of Riga from 1949 to 1961

	Number 0–20 m		20–40 m		Biomass 0–20 m		20–40 m		Number of years of observation
	1961	1949–61	1961	1949–61	1961	1949–61	1961	1949–61	
January	2,840	3,330	970	1,170	39	35	29	30	3
February	1,630	2,410	520	790	34	41	23	21	4
March	4,180	3,710	2,640	1,820	36	39	27	24	3
April	17,740	14,250	1,640	1,700	82	71	22	19	5
May	25,810	16,780	4,810	3,020	466	236	209	113	11
June	36,720	18,400	5,860	3,650	470	261	279	183	9
July	31,190	25,590	4,500	5,690	575	424	241	247	9
August	40,000	35,780	3,470	4,420	472	425	237	215	8
September	—	22,840	—	(14,480)	—	292	—	(390)	6
October	11,920	13,410	5,030	4,360	178	165	149	121	9
November	2,730	3,510	—	2,600	126	105	—	60	7
December	—	(3,420)	—	(3,710)	—	—	—	—	2
Mean	17,480	14,550	3,270	2,920	248	190	135	103	

warm winters (1959, 1953, 1961) and this might be explained by a more intensive feeding of herring and kilka upon the plankton during such winters, when production is relatively poor.

In the early spring, the conditions for the development of zooplankton were good. Until the end of May the quantitative values of zooplankton were at the level of the long-term averages and exceeded considerably the values for the years with cold winters and springs (1960, 1958, 1956), and that in spite of the very depleted stock of hibernating zooplankton. The species not eaten up by the fish rotifers (Rotatoria) were very numerous in the spring of 1961. The abundance of Synchaeta (largely *S. baltica*) was the greatest for all the years of investigation.

The main feature of the summer plankton was the abundance of copepods and rotifers, while the production of cladocerans was very poor. In August the average values of abundance and biomass were noticeably above the long-period averages; lower values were only observed in the 0—100 m layer in the years 1958 and 1957. In the deepest part of the sea the abundance and biomass of zooplankton were the greatest for the whole period of observation.

In connection with an influx of great amounts of salt water into the deep-water zone of the Gothland Deep in August 1961 there was an unparalleled abundance of salt-water species, viz. *Oithona similis* and *Sagitta elegans baltica*.

The concentration of food plankton (for fish) in the autumn (end of October) was at the level of the long-period mean.

I. I. Nikolaev, S. O. Apinė, H. K. Krievs

PART III.

THE FISH

A. Distant Northern Seas

Redfish

Redfish Larvae from Ocean Weather Station "A" in 1960 and 1961

(Table 1)

The following observations are a continuation of those reported in Rapp. et Proc.-Verb., **150**: 194, and the same methods were used.

Table 1 gives the number and lengths of *Sebastes* larvae caught in all hauls in April and May: no hauls were made in those months in 1959. All hauls were made between 2100 and 2300 local time. All larvae appear to be those of *S. marinus*.

Table 1

Date	Number of larvae	Length in mm 6	7	8	9	10	Mean length, mm
1960							
12. May	7	—	4	3	—	—	7.79
18. May	2	—	1	—	1	—	8.50
25. May	4	—	1	1	2	—	8.75
1961							
15. April	2	1	1	—	—	—	7.00
22. April	2	—	1	1	—	—	8.00
27. April	1	—	1	—	—	—	7.50
2. May	13	—	6	7	—	—	8.04
10. May	41	—	16	23	2	—	8.16
15. May	4	—	2	2	—	—	8.00
21. May	5	—	—	3	1	1	9.10

JOHN CORLETT

Danish Investigations in West Greenland

(Table 2)

The continuing trawling experiments for small redfish in the Godthåb Fjord, which started in 1952, have been carried out in every month in 1961 with exception of June. The total catch amounted to 9,072 redfish. Length distributions of the samples will be presented in I.C.N.A.F. Sampling Yearbook.

No tagging experiments were carried out in 1961.

Eleven of the 281 redfish tagged in Qorqut in the Godthåb Fjord in 1960 were recaptured in 1961; 5 were recaptured in the tagging locality. Another 5 at Kapisigdlit in the innermost part of the fjord, about 30 miles from Qorqut. Of special interest is a recapture taken by an Icelandic trawler south of Fiskenæs Bank (62°55′N,

Table 2. Length frequencies (cm) of redfish caught with shrimp trawl (single hauls) by the M/C "Adolf Jensen" in the Godthåb Fjord, 64°25′N—50°19′W

Date	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1961																			
January ..	—	—	1	5	20	34	71	80	38	21	29	64	81	35	35	34	25	5	5
February .	1	1	4	22	57	99	298	271	84	99	182	287	296	195	168	178	83	48	54
March	4	11	3	16	46	46	149	242	96	41	86	156	170	141	100	51	37	9	1
April	—	20	6	9	44	57	136	242	162	43	54	107	143	111	53	66	38	22	11
May	—	3	7	3	23	12	32	105	69	27	21	28	19	26	21	16	9	7	8
July	—	—	3	7	5	9	9	16	42	19	8	5	5	7	3	4	—	2	3
August ...	—	1	6	6	1	5	8	19	44	41	17	8	21	23	17	18	16	8	4
September	—	—	6	3	1	9	19	43	61	34	13	24	31	41	37	40	18	14	8
October ..	—	—	3	4	—	2	6	19	56	40	20	18	52	70	49	51	43	38	16
November	—	—	2	4	1	1	7	9	19	34	15	13	22	29	45	45	28	28	14
December .	—	—	—	5	4	1	5	6	48	56	48	24	52	86	101	102	69	70	45

Date	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	>40	No. of fish
1961																		
January ..	5	6	2	3	2	3	—	—	1	1	1	1	—	—	—	—	2	610
February .	43	35	34	19	10	5	4	2	2	1	1	2	1	1	1	3	3	2,594
March	3	5	3	6	4	—	3	1	3	2	4	—	—	—	1	1	3	1,444
April	11	10	6	2	7	—	3	1	1	—	1	—	—	—	—	—	1	1,367
May	7	3	3	2	1	—	—	—				—	—	—	—	—	2	154
July	—	1		1				1		1		—	2	2	1	—	—	196
August ...	6	7	6	2	—	—	—	—	1	—	3	—	1	—	2	1	2	294
September	3	—	2	3	2	2	3	—	1	1	—	—	—	—	—	—	—	419
October ..	8	6	6	9	4	6	5	1	6	2	3	2	—	—	—	1	—	546
November	7	9	5	7	3	4	2	—	3	2	1	—	—	—	1	1	3	364
December .	16	15	14	12	14	8	7	1	1	4	4	3	—	1	—	1	1	824
																	Total	9,072

52°05′W), 11. August 1961. The fish was tagged on 24. May 1960 at Qorqut. Total lengths at tagging and at recapture were 43.5 cm and 44.5 cm respectively. This recapture probably indicates that the stock of redfish in the Godthåb Fjord is not a local one.

P. M. Hansen

Halibut

The Scottish Halibut Fishery in 1961

(Figure 1; Tables 3–5)

About 92% of the halibut landings in Scotland are made at Aberdeen, and only these landings are dealt with in this report. Table 3 shows the fishing effort and weight landed by British trawlers in each month from the various grounds. Faroe was the main ground accounting for 82% of the landings. The corresponding data for liners are shown in Table 4 and again the highest proportion of the landings (55%) came from Faroese grounds.

Trawled halibut from Faroe were measured regularly at the Aberdeen Fish Market. The smallest halibut found in the landings was 22 cm long but in general fish of less than 26 cm were not common and made up only a very small fraction of the landings by weight. The size distribution of the landings in various months is given in Figure 1. The bulk of the landings are made up of only two broods and at the beginning of the year these had modal lengths of 30 cm and 40 cm respectively. The 30 cm group represented the brood which had entered the fishery as recruits a few months earlier — in the autumn of 1960, and the 40 cm fish were approximately one year older than this. In August the recruits of 1961 began to appear in small numbers at lengths of about 25 cm, and by the autumn, coinciding with a marked increase in the catch per 100 hours' fishing (Table 5), they were abundant in the landings, appearing in the October market samples at a modal length of 27 cm. The mean catch per 100 hours was 9.9 cwt, — about 16% lower than the corresponding value for the previous year.

Table 3. Monthly fishing effort and weight of halibut landed at Aberdeen by British trawlers in 1961

Ground	Faroe		Iceland		North Sea		West Coast		Other Grounds	
Month	Cwt	Hours fishing	Cwt	Hours fishing	Cwt	Hours fishing	Cwt	Hours fishing	Cwt	Hours fishing
January ..	830	9,197	4	84	91	13,729	22	3,100	—	—
February .	853	11,638	—	—	86	13,245	32	2,727	—	—
March	759	11,382	213	1,341	68	14,999	44	2,924	5	195
April	434	7,033	66	2,782	95	14,088	62	3,014	—	—
May	524	5,303	357	8,084	60	13,073	146	7,015	7	70
June	1,581	16,222	148	1,447	34	13,973	54	3,760	57	1,607
July	1,611	16,617	39	705	54	14,671	46	3,376	4	276
August ...	1,305	14,783	40	716	77	16,670	68	4,618	—	—
September	1,212	9,945	94	962	101	20,798	20	3,432	—	—
October ..	1,079	8,753	71	1,831	72	17,026	22	3,216	—	—
November	1,029	8,640	84	1,070	54	19,471	21	3,135	—	—
December .	1,346	9,098	188	1,359	77	21,929	17	2,391	—	—
Total	12,563	128,611	1,304	20,381	869	193,672	554	42,708	73	2,148

Table 4. Monthly fishing effort and weight of halibut landed at Aberdeen by British liners in 1961

Ground	Faroe		Iceland		North Sea		Rockall		Other Grounds	
Month	Cwt	Hours fishing	Cwt	Hours fishing	Cwt	Hours fishing	Cwt	Hours fishing	Cwt	Hours fishing
January ..	25	505	18	55	—	12	—	—	—	—
February .	118	2,145	37	365	40	440	—	—	—	30
March	299	2,032	278	280	78	362	15	450	—	—
April	874	2,203	617	557	137	685	57	520	8	100
May	1,799	4,850	656	705	376	2,385	360	1,567	107	145
June	772	2,820	88	225	489	2,982	360	2,615	317	440
July	1,381	4,525	264	1,215	150	1,190	366	3,347	—	—
August ...	952	2,907	454	1,545	218	1,562	312	3,040	4	65
September	972	3,803	362	850	222	2,077	62	575	—	—
October ..	927	3,322	692	910	98	910	—	—	—	—
November	506	3,515	226	655	—	—	—		—	
December .	192	2,380	122	825	—	70	—	—	—	—
Total	8,817	35,007	3,814	8,187	1,808	12,675	1,532	12,114	436	760

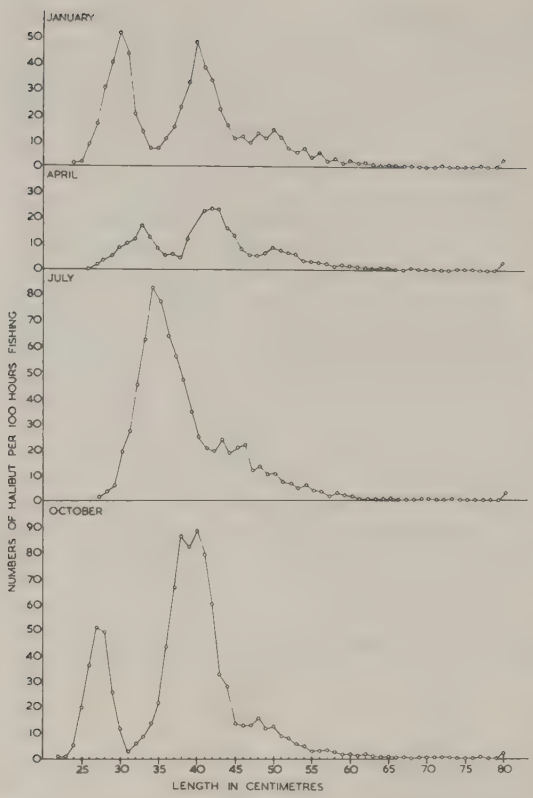


Figure 1. Length distribution of halibut landed in various months.

Table 5. Catches per unit of effort for British trawlers and liners landing at Aberdeen from Faroese grounds in 1961

	Trawlers	Liners
	Catch per 100 hours (cwt)	Catch per 100 lines (cwt)
January	9.1	2.5
February	7.3	2.8
March	6.7	7.4
April	6.2	19.8
May	9.9	18.6
June	9.9	14.2
July	9.6	15.2
August	8.7	16.4
September	12.2	12.2
October	12.3	14.0
November	12.0	7.2
December	14.8	4.0

The line fishery at Faroe was concertrated on older fish in deeper water: altogether 33 vessels took part in this fishery and made a total of 225 trips throughout the year. Lining took place round the islands (Sandø, Syderø, and Nolsø Banks, and off Munken Rock) or on the oceanic banks (Faroe, Bill Bailey's, and Lousy Banks). In general the best catches came from the latter areas. Halibut landed by liners were almost entirely over 60 cm long and over 5 years in age. Catches per unit of effort are shown in Table 5. The mean catch per 100 lines for 1961 was 11.3 cwt, about 9% less than that of the previous year.

A. D. McIntyre

Rare Fish

Germany

Both the German scientific institutions in Hamburg (IfS) and Bremerhaven (BAH) received only very few rare fishes from the two fish markets during 1961. Many more, however, were obtained from the stomachs of cod investigated on board F.R.S. "Anton Dohrn" and the commercial trawler "Hermann Ahlers". Only the most remarkable species are mentioned here; the lengths are given as total lengths measured to the cm below, the dates refer to the actual day of capture unless otherwise stated. Fishes actually caught by trawl are marked by the words "caught" or "landed" respectively, the others being found in the stomachs of *Gadus morhua*. All identifications are made by the author, except that of *Rhinochimaera*, the data of which are kindly procured by Dr. Kotthaus.

Borostomias macrophthalmus Regan & Trewavas, 1929
1. December 1961, 65°30′N — 30°30′W, 385 m depth, 1, about 12 cm, IfS.

Centrolophus niger Lacépède, 1803
caught 3. August 1961, 63°37′N — 12°26′ W ("Rosengarten"), 425 m depth, 1, 42 cm, IfS.

Diplolychnus bifilis Regan & Trewavas, 1929
27. July 1961, 64°40′N — 35°08′W, 450 m depth, 1, 19 cm, IfS.
First record for East Greenland.

Eurypharynx pelecanoides Vaillant, 1882
1. December 1961, 65°30′N — 30°30′W, 385 m depth, 1, only skull and jaws of a specimen of abt. 50 cm, IfS.
First record for East Greenland.

Gonostoma bathyphilum (Vaillant), 1884
19. July 1961, 64°40′N — 35°12′W, 400—420 m depth, 1, 14 cm, IfS.
27. July 1961, 64°40′N — 35°08′W, 450 m depth, 1, 7 cm, IfS.
1. December 1961, 65°30′N — 30°30′W, 385 m depth, 3, 9, 8 and 7 cm, IfS.
3. December 1961, 65°30′N — 30°03′W, 310—320 m depth, 1, 7 cm, IfS.
First record for East Greenland.

Himantolophus groenlandicus Reinhardt, 1837
landed 25. August 1961, NE edge of Fiskenæsbank, 200 m depth (by commercial trawler), 1♀, 47 cm, IfS.

Lampadena braueri Zugmayer, 1914
1. December 1961, 65°30′N — 30°30′W, 385 m depth, 1, 14 cm, IfS.

Linophryne lucifer Collett, 1886
Caught 21. July 1961, 64°38′N — 35°07′W, 400—430 m depth (by commercial trawler), 1 ♀, 23 cm, IfS.
Hitherto only two specimens of the species seem to be known, moreover this might be the largest one of the whole genus so far recorded.

Malacosteus niger Ayres, 1857
19. July 1961, 64°40′N — 35°12′W, 400—420 m depth, 1, 20 cm, IfS.
1. December 1961, 65°30′N — 30°30′W, 385 m depth, 2, 14 and 16 cm, IfS.

Notosudis lepida Krefft & Maul, 1955
10. July 1961, 63°28′N — 12°15′W, 420 m depth, 1, 10 cm, IfS.

Paralepis brevis Zugmayer, 1911
28. July 1961, 64°35′N — 35°08′W, 400 m depth, 1, 50 cm, IfS.

Platytroctes apus Günther, 1878
1. December 1961, 65°30′N — 30°30′W, 385 m depth, 1, abt. 12 cm (badly damaged), IfS.
In the Atlantic hitherto known only from a narrow belt between 20°N and 30°N. First record for East Greenland.

Rhinochimaera atlantica Holt & Byrne, 1909
Caught 3.—6. April 1961, 62°55′N — 23°57′W, 530—600 m depth (by commercial trawler), 1♂, 112 cm, BAH.

Saccopharynx ampullaceus (Harwood), 1827
1. December 1961, 65°30′N — 30°30′W, 385 m depth, 1, abt. 128 cm (tail broken), IfS.

Searsia koefoedi Parr, 1937
27. July 1961, 64°40′N — 35°08′W, 450 m depth, 2, 13 and 10 cm, IfS. A reexamination of our material showed that amongst the searsids collected by us in East Greenland waters and recorded for the year 1958 as *Searsia schnakenbecki* Krefft, 1953 two specimens of *koefoedi* had been overlooked.

Xenodermichthys copei (Gill), 1884
9. July 1961, 63°00′N — 10°55′W, 455 m depth, 1, 16 cm, IfS.

G. Krefft

B. Near Northern Seas

Flatfish

Plaice and other Flatfish in the Kattegat

(Tables 6–8)

1. Coastal investigations on the 0- and I-groups

Fishing for 0-group plaice with the Johansen young-plaice trawl was carried out in July, August, and the first days of September. The force and direction of the wind hindered investigations on the Skagerak coast and partially also in the Kattegat. Therefore the number of fully reliable stations in the northern Kattegat was lower than usual. The results given for this coast in Table 6 are based on 3 stations only, but the high number of fish is undoubtedly approximately reliable because 6 stations worked in a too rough sea yielded the relatively high average of 100 0-group and 49 I-group plaice per hour.

The frequent strong winds prevailing in the summer of 1961 may have caused many of the young fish to seek deeper waters than those of the coastal stations.

In the westernmost part of the Nissum Broad a high number of 0-group and I-group plaice was taken. The investigations here have, however, been operated for too few years for the assessment of a true normal density. The numbers of 0-group fish present here seemed to be somewhat over normal, and those of the I-group must be considerably over normal. In the northern and central Kattegat the density of 0-group fish was about 3 times the normal, that of the I-group below normal in the northern Kattegat but above normal in the central Kattegat. In the southern Kattegat the density of both 0- and I-group plaice was very low.

Table 6. Numbers of 0- and I-group plaice caught per hour with the Johansen young-plaice trawl in coastal waters in July/August 1961

	Number of stations	0-group 1961	0-group Mean	I-group 1961	I-group Mean
Nissum Broad		508	—	128	—
N Kattegat ..	3	308	97	26	55
C Kattegat ..		108	37	42	12
S Kattegat ..		2	20	0.2	2
Skälderviken .		3	—	0.5	—
Laholm Bay .		33	—	0.5	—

Table 7. Danish catches of plaice per hour's trawling from R.V. "Biologen" in the northern Kattegat, October 1961
(Lengths to the nearest lower whole cm. S = Standard trawl; H = Nephrops trawl)

Depth, m	Gear	Number of stations	Age-groups I	II	III	IV	Centimetre groups 6–10	11–15	16–20	21–25	26–30	Total
6–14	S	4	137	448	150	18	—	174	382	168	33	757
15–24	S	4	431	568	42	2	0.5	532	449	50	5	1,036
25–34	S	3	7	57	11	1	—	15	45	12	4	76
35–44	S, H	2	53	101	13	—	—	26	115	21	4	166
45–60	H	2	10	54	13	2	—	11	37	24	5	77

In Skälderviken and Laholm Bay fishing was carried out from the "Havkatten" with permission of the Swedish Government. In Skälderviken the number of plaice was very small, and also in Laholm Bay the yield was lower than in most previous years.

The numbers of 0-group flounder, turbot, brill, and sole were very small at all the coastal stations, but the open coasts investigated are not the preferred habitat of the flounder, and the other species have only been encountered on these coasts in appreciable numbers in some few previous years. An average of about 4 I-group sole was found in the Nissum Broad but none on the other coasts.

2. The stock of plaice in the open sea

The results of the fishery with the standard trawl from the R.V. "Biologen" in October 1961 are shown in Table 7. A large stock of undersized fish, mainly of the 1959 and 1960 year-classes, but partially also 1958, was found there. Of the 1959 year-class a considerable number must have immigrated from the Skagerak, as much fewer specimens of that year-class were previously found there.

In this region the commercial fishery has been mainly based on the rich 1957 and 1958 year-classes. Here the growth of the plaice is relatively slow.

In the second half of the year an extensive commercial fishery was carried out in the central Kattegat and it was essentially based on the 1958 and 1959 year-classes. The weight of each landing was more than twice that of the autumn 1959, but the average length of the plaice landed had decreased about $^1/_2$ cm to approximately 28 cm. Table 8 shows the length distribution as compared with previous years. About 95% of the plaice were below 30 cm, and the fishermen complained that the many undersized fish impeded the fishery.

Very few specimens of the 1959 year-class were found as 0-group in the central and southern Kattegat, while it was a very rich brood in the Belts and the Skagerak. It seems likely that an immigration has taken place from both sides.

In December the average length of the plaice in the outer Aalborg Bay between the lightvessel and 10 m north of Fornæs, where fishing was very intensive, was about 1 cm lower than the year before. Nearer Fornæs the average length had only decreased about $^1/_2$ cm, but about 15 m east of Fornæs and at Briseis Flak (ca. 5 miles SE of Fornæs) the decrease was between 3 and 4 cm.

AAGE J. C. JENSEN

Table 8. Length distribution (%) and average length of plaice in Danish commercial catches from the Kattegat in 1961
(Lengths to the nearest lower whole cm. Averages corrected)

	Depth, m	Number of hauls	Length, cm 26–27	28–30	31–35	36–40	41–45	45–50	51–55	Mean
10–25 miles N-NNW of Fornæs										
1960, Sept.-Dec.	11–15	5	29	27	24	15	4	—	—	29.3
1961, Oct.	12	3	54	44	2	—	1	—	—	28.2
5 miles E, NE, and N of Fornæs										
1960, Nov.-Dec.	15–16	2	28	25	21	21	6	—	—	31.9
1961, Dec.	16–17	2	12	43	36	9	1	—	—	31.4
15 miles E of Fornæs										
1960, Oct.–Nov.	21–25	3	4	14	46	29	4	2	—	34.8
1961, Oct.–Dec.	21–24	3	12	38	41	8	1	—	0.3	31.5
10 miles SE of Fornæs										
1960, Dec.	18–28	2	4	15	40	36	5	—	—	34.8
1961, Oct.	21	1	21	42	32	3	1	—	—	30.4

The Norwegian Taggings of Spiny Dogfish *(Squalus acanthias)*

(Figures 2–12; Table 9)

Tagged spurdog were released on 3 cruises during 1961. In all 2,045 specimens were liberated, of these a total of 74 tags were recovered. From the earlier taggings, comprising 3,749 fish, 140 tags were recaptured. In Table 9 is given a summary of the taggings and the recoveries for each year since the tagging work commenced in 1958. For the liberation areas and localities are entered code numbers, the key to which is found in Figure 2.

In Figures 3—5 is given a representation of the recoveries with time and place records from the first experiment in the years 1959—60. There are two recaptures outside the area covered by the chart: One in June 1959 at Thor Iversen Bank in the Barents Sea and another west of Tralee Bay, Ireland in December 1960. The recoveries in the months January/March are denoted by black circles, April/June by half black half open circles, July/September by open circles, and those of October/December by circles with a black sector. It will be seen that the black circles dominate on the Norwegian coast in 1959. For the next three months the recoveries are found more to the west and in July/September the recaptures are made almost exclusively in the region Orkneys — Shetland. In the last three months of the year the recoveries are again beginning to appear more to

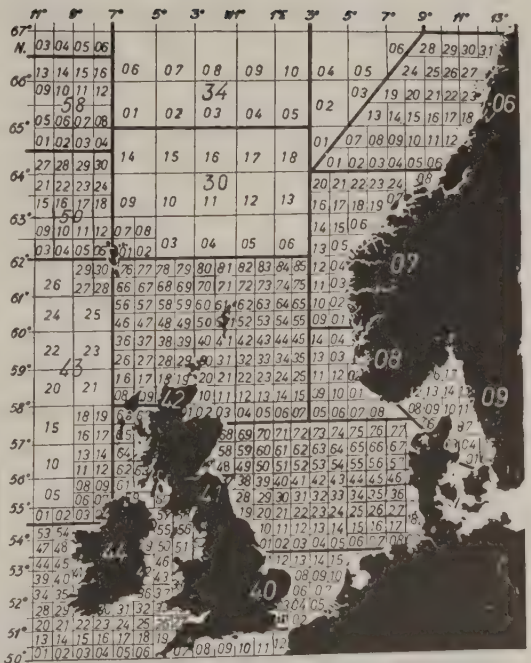
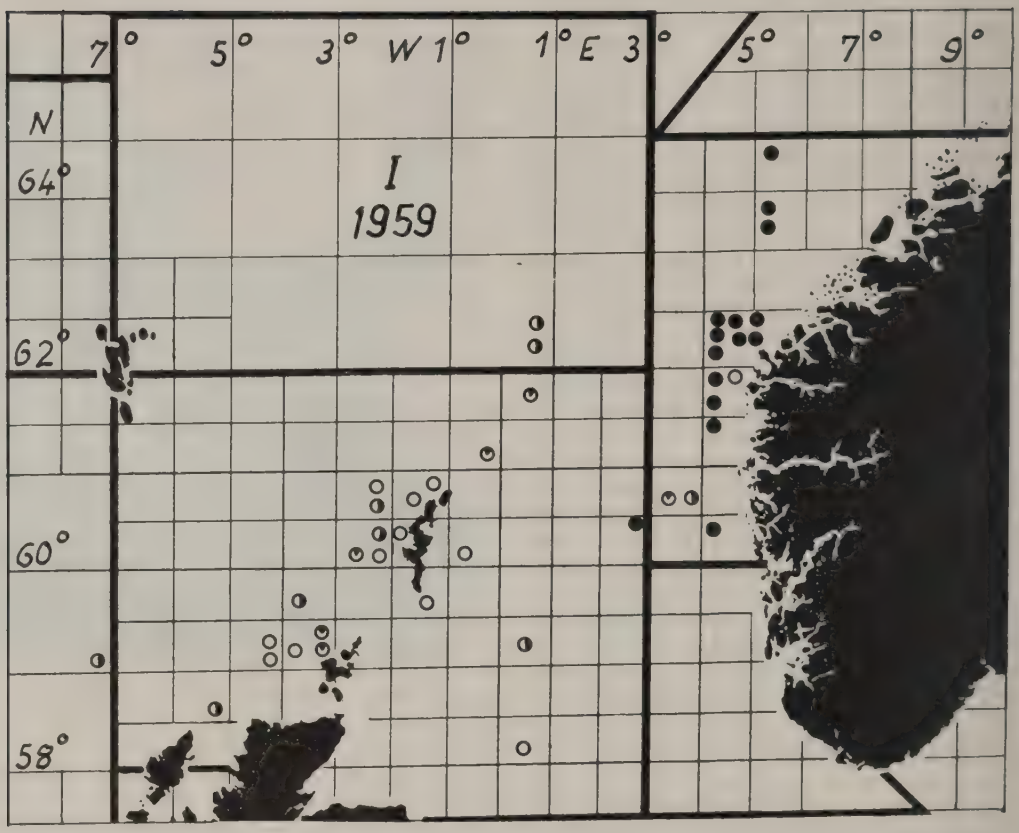


Figure 2. Key to code numbers in Table 9.

Table 9. Taggings and recoveries of spiny dogfish 1958—1961

Taggings:						Recoveries:									
						1958		1959		1960		1961		Total	
Exp. No.	Year	Month	Area	Localities	Number	n	%	n	%	n	%	n	%	n	%
I	1958	Nov.	42	17 50	1,000	6	0.6	43	4.3	59	5.9	27	2.7	135	13.5
II	1959	Nov.	41	60 68											
			42	03 16 18 20 29 35	989			4	0.4	55	5.6	31	3.1	90	9.1
			42	39 50 62 65											
III	1960	Jan.	07	01 03 04 05 06 07 15	531					48	9.0	25	4.7	73	13.7
IV	1960	Apr./May	07	02 13											
	,,	,,	42	84	10					2	20.0	0	0	2	20.0
V	1960	July/Aug.	42	18 26 50											
	,,	,,	43	06 07 18	969					9	0.9	42	4.3	51	5.3
	,,	,,	44	21 44[1])											
VI	1960	Nov./Dec.	07	01 02											
	,,	,,	08	02 03 04	250					2	0.8	15	6.0	17	6.8
VII	1961	Jan.	06	05 06 11 12 18 23 27											
	,,	,,	07	05 06 08 14 18 24	894							70	7.8	70	7.8
VIII	1961	Oct./Nov.	42	27 28 39 50	1,000							3	0.3	3	0.3
IX	,,	Nov./Dec.	07	02 03 04	151							1	0.6	1	0.6
				Total:	5,794	6	0.6	47	2.4	175	4.7	214	3.7	442	7.6

[1]) The exact liberation locality was slightly to the west of square 44.



Figures 3–5. Distribution of recaptures from experiment I in 1959, 1960 and 1961. Jan.–March, ◗ Apr.–June, ○ July–Sept., ▼ Oct.–Dec.

the east. For 1960 one finds a similar pattern in the distribution of the recaptures. There are, however, notably more recaptures on the Norwegian coast during the summer and autumn than for 1959. This feature must be due to migratory differences. The increase in recaptures for January/March from 1959 to 1960 is caused by heavier fishing: The increase in the catch amounts to about 80 per cent. There is a sharp drop in the number of recaptures from 1960 to 1961 (Figs. 4 and 5 and Table 9), but the general picture is much the same.

The distribution of the recaptures from the second tagging experiment for 1960 and 1961, is shown in Figures 6 and 7. There is one recovery outside the chart, made in the Vestfjord, Norway (arctic circle), August 1960. Broadly speaking, the pattern is similar to that of the first experiment. The main difference is the concentration of recaptures in the Viking Bank region in 1960 from the second experiment. Another difference is that the recaptures from experiment II is somewhat underrepresented in 1960 compared with experiment I (Table 9). For 1961 the numbers are more harmonious.

In contrast to the two first tagging experiments in the Shetland waters the third one was carried out on the Norwegian coastal banks. Nevertheless, the distribution of recaptures are very similar. This will be evident from Figures 8 and 9 where the recaptures from the third experiment are plotted for 1960 and 1961 using the same symbols as for the two former experiments. It seems therefore reasonable to conclude, that as a general rule there is a regular migration to the Norwegian coastal banks in the winter and back to the

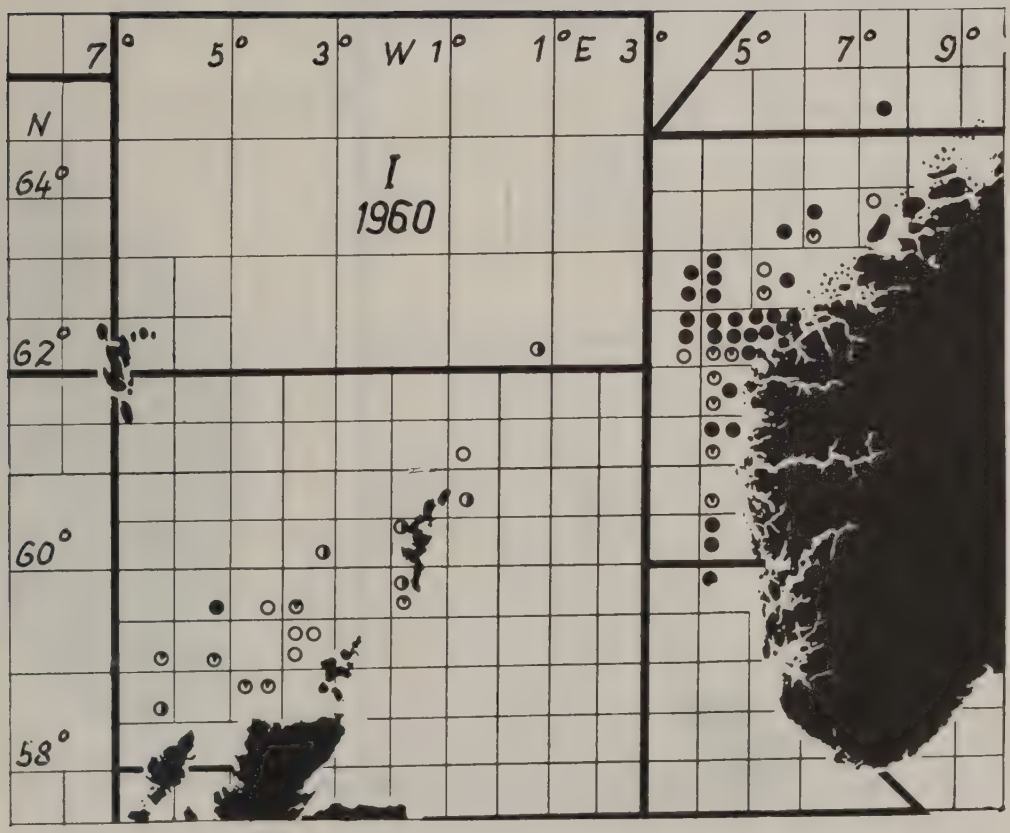


Figure 4.

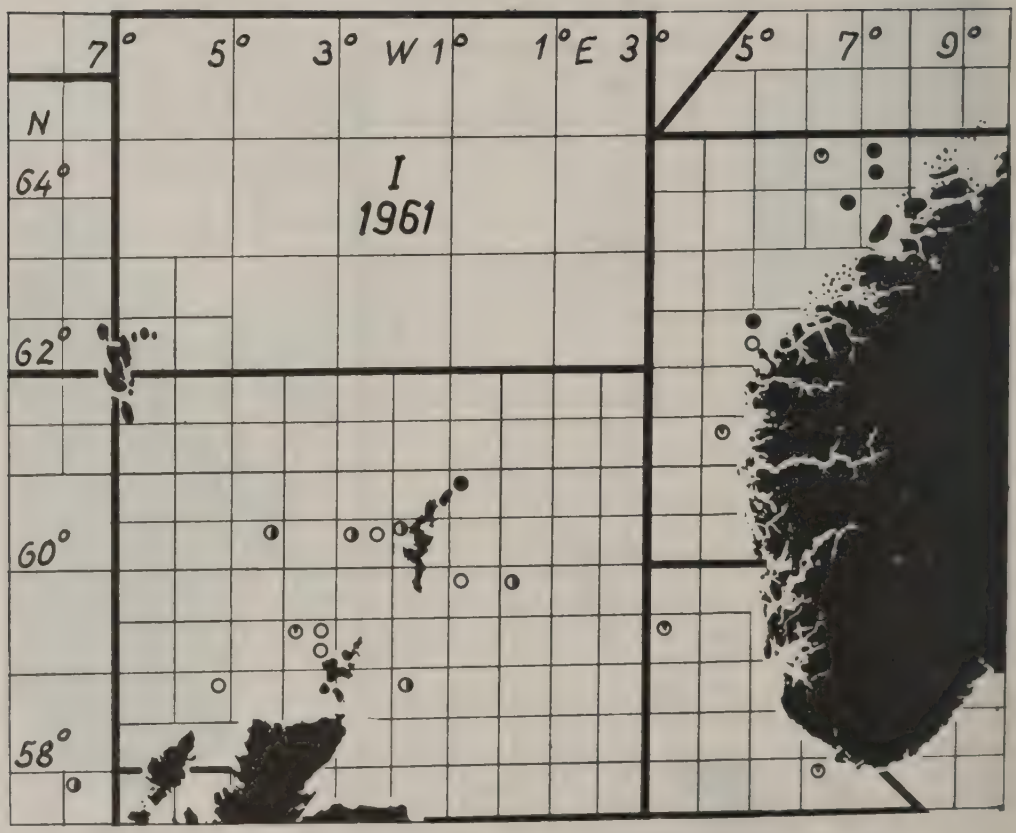
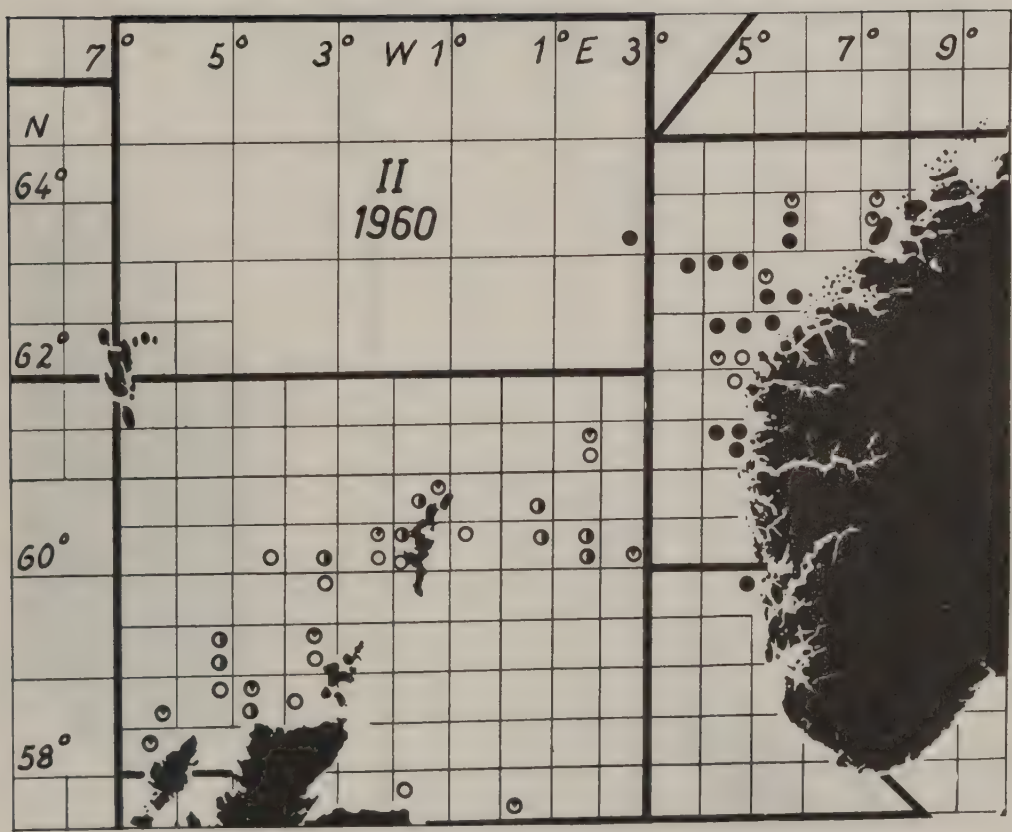


Figure 5.



Figures 6 and 7. Distributions of recaptures from experiment II in 1960 and 1961. Symbols as in Figs. 2-4.

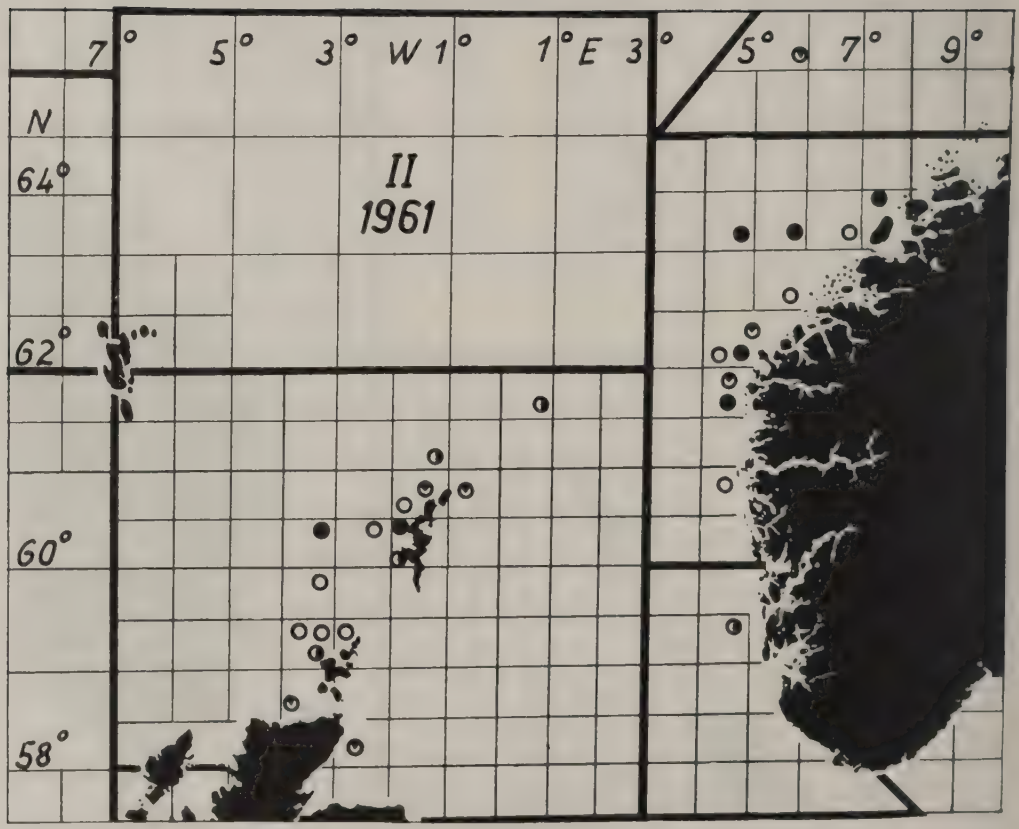
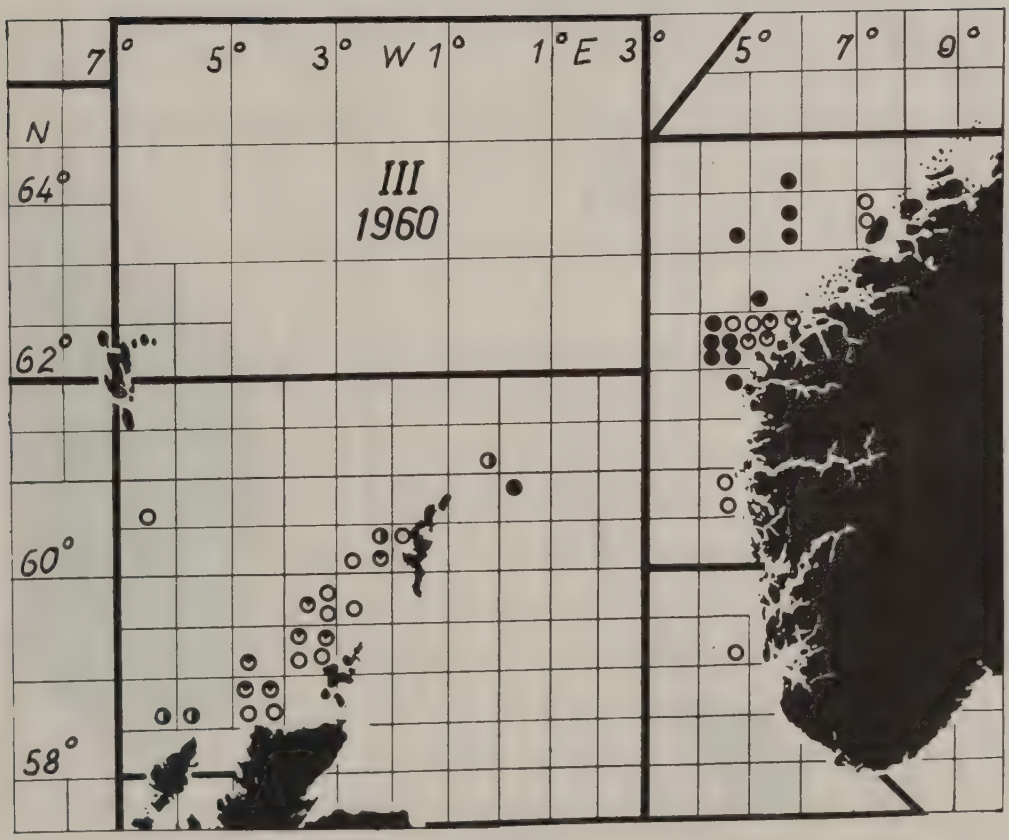


Figure 7.



Figures 8 and 9. Distributions of recaptures from experiment III in 1960 and 1961. Symbols as in Figs. 3–5.

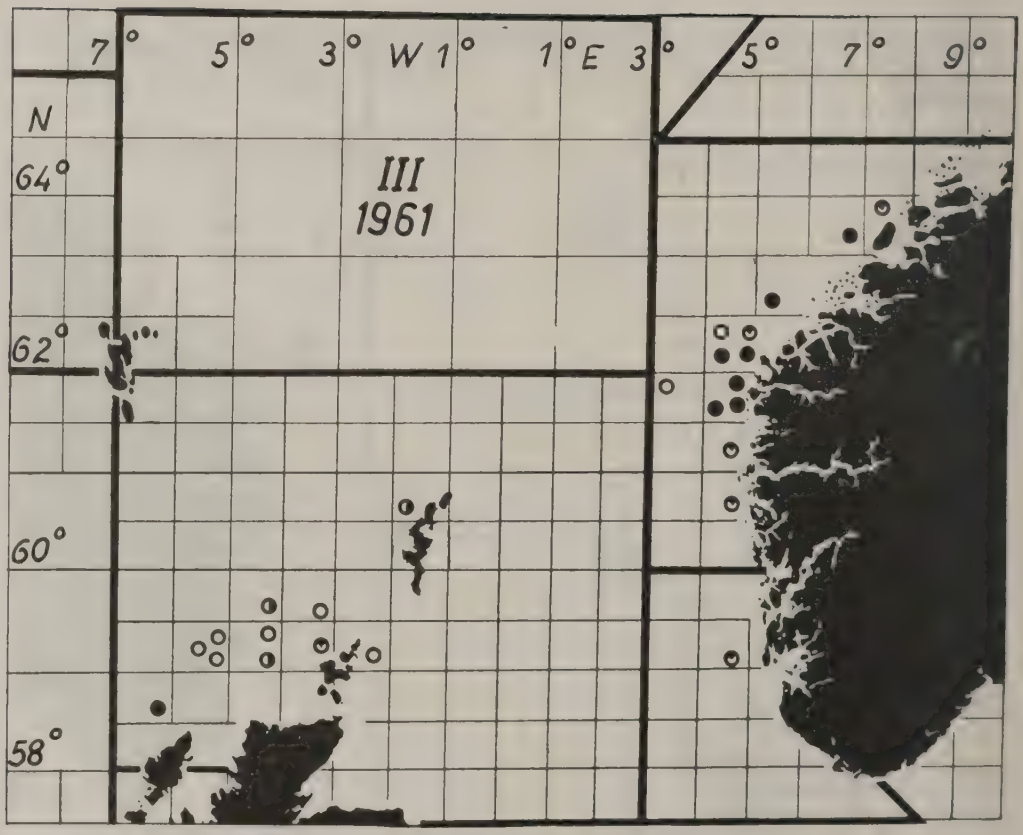
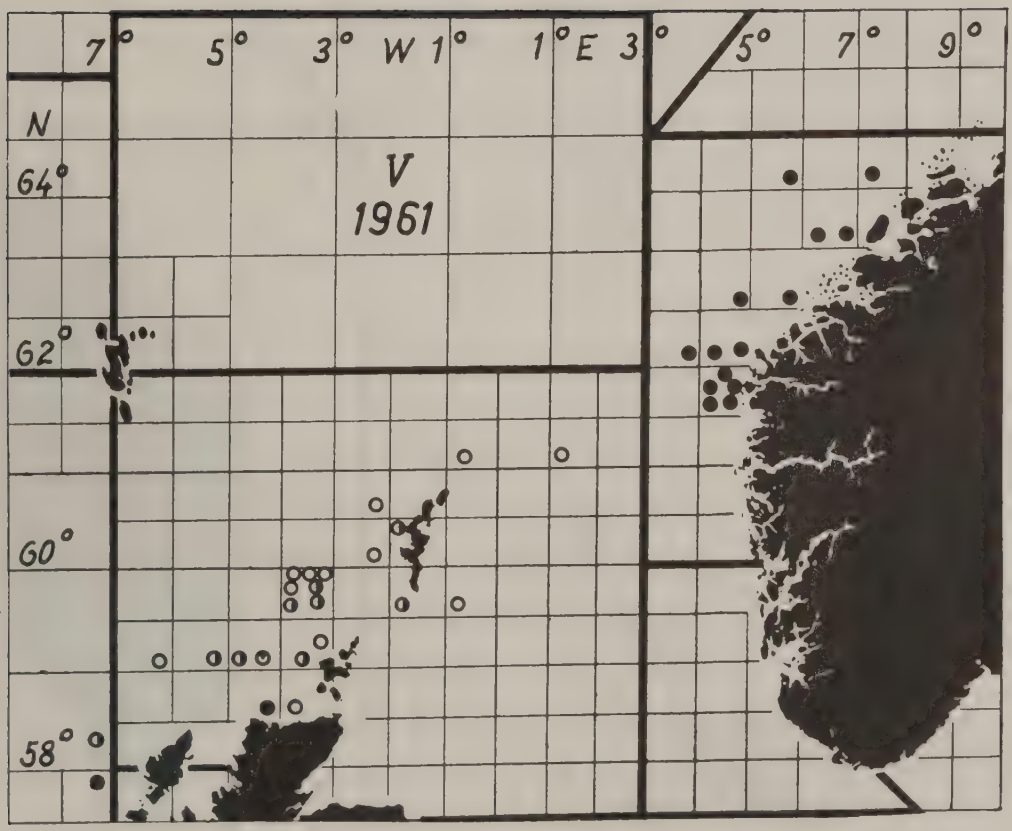


Figure 9.



Figures 10 and 11. Distribution of recaptures from experiments V and VII in 1961.

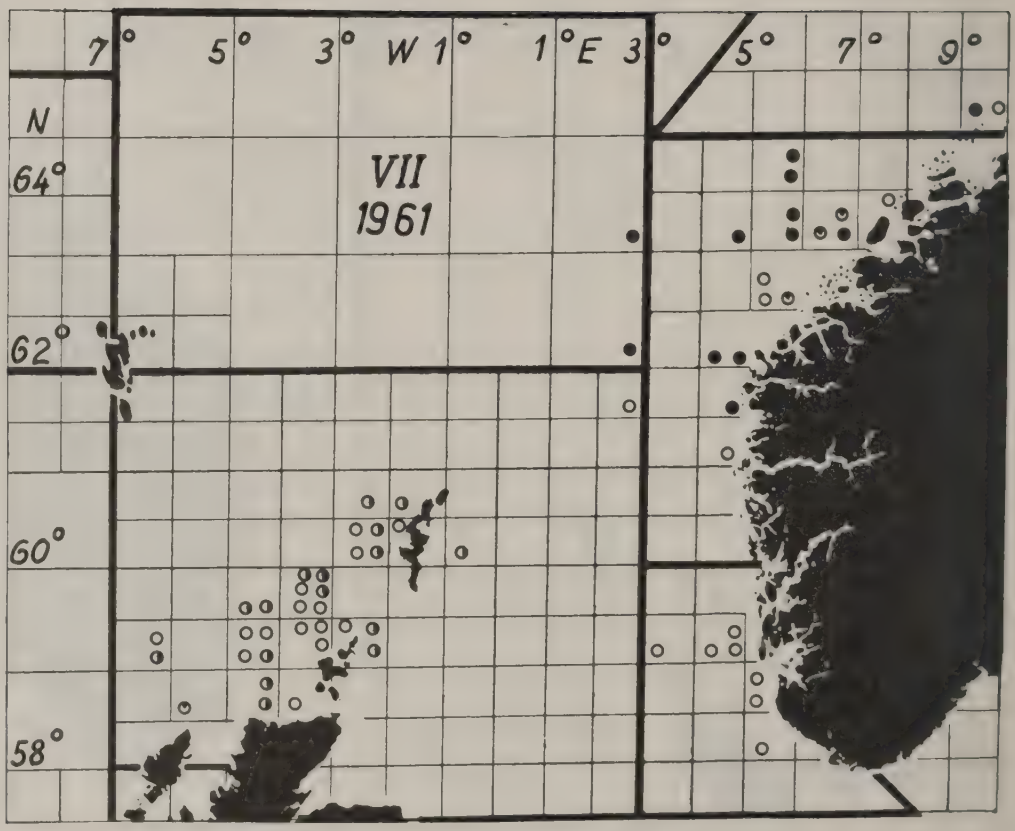


Figure 11.

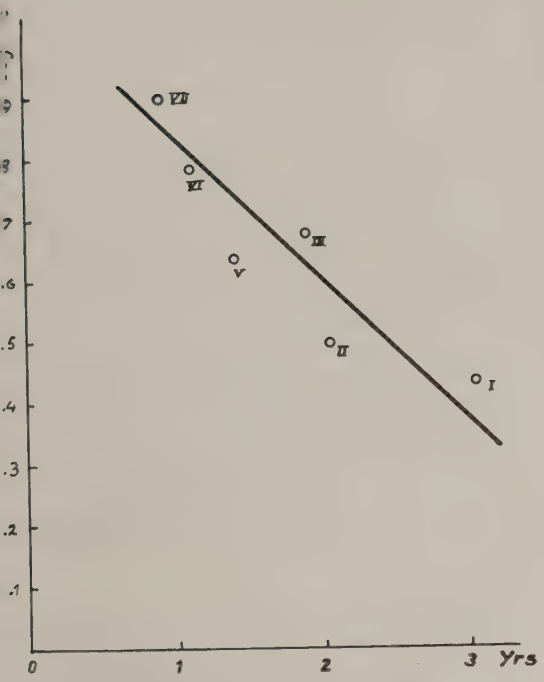


Figure 12. Mortality rate in the spurdog population. Logarithms of recapture percentages in 1961 (log r %) for experiments I, II, III, V, VI and VII, plotted against time in liberty. (F + M = 0.25).

Hebrides — Shetland grounds in summer. The experiments V and VII corroborate this conclusion. In Figures 10 and 11 are represented the distributions of the recoveries from these two experiments in 1961. Also here there are irregularities. From experiment V in the Shetland waters there is one recovery in the German Bight (Fig. 2, area 41, locality 26) in December 1960, and from the taggings on the Norwegian banks in 1961 there is one recovery south of the Hebrides (Fig. 2, area 44, locality 64) in November of the same year. A notable difference between the two experiments is that there are no recaptures on the Norwegian coast from experiment V outside January/March, while there is a considerable number of recaptures in the summer off the Norwegian coast from experiment VII (Fig. 11). Especially striking is the concentration of recoveries on the south-western part of the coast (area 08).

Experiment IV contains too few liberated fish and VIII and IX have so far given too few recoveries to justify further comments. Experiment VI was carried out in the fjords between Bergen and Stavanger and it is an interesting fact that most of the recoveries have been made not very far from the liberation localities. The spiny dogfish found in the fjords seems to a large extent to be stationary. But two recaptures, one off the Faroes and one north of the Viking Bank (Fig. 2, area 30, localities 01 and 06), show that the spurdogs in the Norwegian fjords are linked with the main stock and are probably to be considered but strays from the same.

The percentages of returns from the various experiments entered in Table 9, may be utilized to estimate the mortality rate in the spurdog population. Plotting the logarithms of the recapture percentages in 1961 against the time of liberty, taking the end of 1961 as zero, one obtains a series of points shown in Fig. 12. The regression line is drawn freehand and the slope corresponds to a total yearly mortality rate of 0.25.

OLAV AASEN

The German Sand-eel Fishery in 1961

(Table 10)

The continuation of the German sand-eel investigations at the Institut für Küsten- und Binnenfischerei in 1961 brought the following results: —

(1) The landings, amounting to 4,512 tons = 383,000 DM, show a further considerable decline (1960 = 7,733 tons; 1959 = 17,246 tons; 1958 = 20,179 tons; 1957 = 25,505 tons).

(2) The fishing season from May to July was shorter than usual (April-August). 95 per cent of the catches were obtained in June. Fishing grounds were mostly: Terschellinger Bank but also IJmuiden-Grund, Well-Bank, Bolders Bank, and Süd-Riff.

(3) The length composition of 11 samples of the two species of *Ammodytes* is given in Table 10. The length composition of *A. lancea marinus* shows, if compared with that of the preceding year (MEYER-WAARDEN, Ann. Biol., **17** : 108, 1962), that the maximum of the 1960 length curve has shifted from 11 cm to 15 cm in 1961 which most likely will account for the annual length increase of the same year-class. Thus the length composition of the 1961 catch is similar to that of 1959 when the predominant length group measured 15 cm. It will be interesting to know whether the sand-eel stock fished on by the Danish fishery along the Danish coast shows the same fluctuations of age composition or if another fluctuation pattern of the structure of the stock may indicate the existence of two or more separate populations of this species.

Table 10. Length distribution (‰) of the 1961 catch of *Ammodytes lancea marinus* and *A. lanceolatus*

	cm	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	33
A. lancea marinus n = 5,840		2	7	53	182	196	119	111	150	89	51	28	10	2	—	—	—	—	—	—	—	—
A. lanceolatus n = 60		—	—	50	133	100	17	—	50	33	50	50	17	17	83	117	100	50	50	33	33	17

(4) 11 samples of an unsorted catch of 6,062 specimens (= 106 kg) were investigated as to their species composition. The catch composition by weight was as follows:—

Sand-eels	90.8%
Whiting	6.6%
Bastard mackerel	1.0%
Sprat	0.8%
Dab	0.5%
Gurnard	0.1%
Herring	0.1%
Others	0.1%

In the case of sand-eels, 89.0% of the total catch were *A. lancea marinus* and 1.8% only *A. lanceolatus*. Undersized protected fish constituted 1.9% of the total catch, 1.7% of these were undersized whiting and 0.2% undersized dab.

P. F. Meyer-Waarden

Rare Fish

Germany

In 1961 some remarkable fishes were delivered to the "Institut für Seefischerei", Hamburg, representing somehow unexpected or rare findings. The following may be of special interest.

Brama brama (Bonnaterre), 1788

5. October 1961, 55°35'N—1°18'E, 1♂, 54 cm, 1♀, 51 cm (caught by motor lugger).

31. October 1961, stranded in half-dead condition on the shore of Wyk, Island Föhr, 1, 57 cm. First record for the west coast of Schleswig-Holstein.

Chelon auratus (Risso), 1810

1.—5. November 1961, River Elbe, near Brunsbüttelkoog, 1, 15 cm.

Chelon ramada (Risso), 1826

1.—5. November 1961, River Elbe, near Brunsbüttelkoog, 1, 15 cm.

29. November 1961, Medemsand (estuary of the River Elbe), 2, 11 and 10 cm.

Both these species of Mugilidae have never before been recorded for the German Bight. The author has been kindly informed by Dr. H. Kühl, Cuxhaven, that shoals of mullets were observed by fishermen inside the estuary for several weeks in autumn 1961. Two more specimens are preserved in the collection of the "Institut für Fischereibiologie" of the University of Hamburg.

Conger conger (Linnaeus), 1758

16. November 1961, Elbe Estuary, 1, 63 cm.

Echiodon drummondii Thompson, 1837

1. April 1961, 59°37'N—3°43'E, 250 m depth, 1, abt. 30 cm (tip of tail missing).

The specimen was found on board F. R. S. "Anton Dohrn" between *Stichopus*, which probably is the host holothurian of this carapid fish.

4. August 1961, Otterbank at 60°02'N—4°40'W, 200 m depth, 1, 21 cm (from stomach of *Gadus morhua*).

Raja brachyura Lafont, 1873

25. March 1961, 57°17'N—2°57'E, 72 m depth, 1♀, 45 cm.

The capture of a Blonde to the east of the Gut is rather exceptional.

G. Krefft

Scotland

The following rare fishes were recorded in Scotland in 1961:—

Chlamydoselachus anguineus Garman—1: 59°50'N, 06°30'W, V.

Squatina squatina (L.)—3: Flannan Isles—St. Kilda, II; North Minch, VI, VIII.

Torpedo nobiliana Bonaparte—3: Moray Firth, II; No grounds I, XI.

Trygon pastinaca (L.)—2: Moray Firth, IV; 32' NNE Kinnaird Head, V.

Myliobatis aquila (L.)—1: Solway Firth, VII.

Acipenser sturio L.—6: North Minch, I; Moray Firth, IV; Turbot Bank, VI(2); 30' SSE Aberdeen, III; S of Buchan Ness, V.

Alosa alosa (L.)—1: Firth of Clyde, III.

Alosa finta (Cuvier)—1: Solway Firth, VII.

Sardina pilchardus (Walbaum)—1: Solway Firth, VII; 57°47'N, 0°05'E, IV (2); 55°53'N, 0°42'W, X.

Engraulis encrasicholus (L.)—5: Solway Firth, V, VII.

Scomberesox saurus (Walbum)—3: Orkney, XI; Shetland, XI; Firth of Forth, XII.

Belone belone (L.)—2: Kyle of Sutherland (inner Dornoch Firth), V; Peterhead Bay, I.
Coelorhynchus coelorhynchus (Risso)—50: 57°30′N, 09°24′W, XI.
Malacocephalus laevis (Lowe)—5: 57°59′N, 09°24′W, XI.
Trachypterus arcticus (Brünnich)—2: Ness (Lewis, Outer Hebrides), II; 48′ ExN Aberdeen, VI.
Capros aper (L.)—3: Firth of Clyde, I; Shetland, X (2).
Morone labrax (L.)—2: Moray Firth, XII; near Firth of Forth, VI.
Polyprion americanum (Schneider)—2: North Minch, IV; Lousy Bank, X.
Trachinotus glaucus (L.)—1: Solway Firth, VIII (first specimen recorded from Scottish waters).
Brama raii (Bloch)—12: Faroe Bank, X (2); Shetland, IX (2), X (2); 50′ NW Sule Skerry, X; off Cape Wrath, XI; The Reef, X (2); 24′ SE Aberdeen, XI; Orkney XI.
Taractes longipinnis Lowe—1: Sandvoe, Shetland, X (first specimen recorded from Scottish waters).
Mullus surmuletus L.—13: Firth of Clyde, X; Shetland, X; Moray Firth, III, XI; Aberdeenshire coast, inshore VIII, XI, offshore IX, XI, XII(3); off Firth of Forth, VIII(2).
Spondyliosoma cantharus (Gmelin)—7: North Minch, II; Moray Firth, I, II, III, IV, IX, XI.
Cepola rubescens L.—5: Firth of Clyde, VI(2), XII; off Islay (W Coast of Scotland), IV (2).
Sarda sarda (Bloch)—1: 4′ off Red Head (E Scotland), VI.
Mugil chelo Cuvier—8: vicinity Aberdeen, VI(2), VII(4); Moray Firth, VII; Loch Eil (56°50′N, 05°12′W), VI.

B. B. Rae
J. M. Lamont

C. Baltic-Belt Seas

Eggs and Larvae of Various Species

(Tables 11–13)

In the 1961 spawning season the average numbers of eggs per m² near the "Fehmarnbelt" lightvessel were as given in Table 11.

Due to favourable water temperatures in the mild winter 1960/61, the spawning of the cod and flatfishes began already in December/January and reached maximum in March when more eggs per m² were recorded than ever in the course of many previous years (for cod 174, plaice 15, on 1. March; for flounder 564, on 11. March). The quantity of sprat eggs has further increased, too. Only mackerel eggs were less frequent.

It is of some interest to compare the quantities of pelagic fish eggs in 1961 with the average numbers in the years 1954—60 and 1934—43 by adding the monthly mean numbers per m² for each year, as in Table 12.

Table 12.

	1961	Average 1954–60	Average 1934–43
Cod	187	64	138
Plaice	16.5	3.0	4.4
Flounder	318	56	73
Dab	40	29	50
Sprat	122	19	144
Mackerel	6	13	2.4

The quantities of fish eggs floating in the Fehmarn Belt remarkably decreased from 1934/43 to 1954/60, the latter period being characterized by frequent periods of eastern winds causing low water temperatures and salinities. The egg numbers stated in 1961 are much higher than the averages for

Table 11.

		Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
Cod	1961	3	8	27	120	29	—	—	—	
	1934–43	4	15	81	49	24	3	1	—	—
Plaice	1961	—	0.5	6	10	—	—	—	[illegible]	[illegible]
	1934–43	0.5	0.5	2	1	1	—	—	[illegible]	[illegible]
Flounder and Dab	1961	—	2	25	241	48	16	19	7	—
	1934–43	—	—	8	23	35	35	18	3	—
Sprat	1961	—	—	—	—	—	—	89	33	—
	1934–43	—	—	—	—	—	22	60	60	5
Mackerel	1961	—	—	—	—	—	—	5	1	—
	1934–43	—	—	—	—	—	—	1.5	0.2	—

1954—60 and similar to or even larger than for 1934—43, especially for the plaice and sprat. The high figure for the flounder is caused by an accidental catch of a great quantity of eggs just spawned (11. March). The steady increase of sprat eggs during recent years is very remarkable, indicating a recovery of the stock of sprat in the western Baltic. The quantity of mackerel eggs fluctuates in quite another way, it increased considerably from 1934/43 to 1954/60 surpassing the number of plaice eggs. But in 1961 the relationship is inverse.

The spawning season 1961 seems to have been a very good one, as we have never before found so many larvae of cod and flounder in the vertical hauls at the "Fehmarnbelt" lightvessel (Table 13).

Table 13. Mean number of larvae per m²

	March	April	May	(Maximum)
Cod	12	13	8	(30; 21. March)
Flounder	3	17	6	(36; 1. April)

Most probably these cod and flounder larvae did not hatch from eggs spawned in the Fehmarn Belt, but were brought from the north by the bottom current, indicating a strong influx into the western Baltic of water from the northern Belt Sea and the Kattegat. Findings of indicator species of the Kattegat water in those months (*Hybocodon, Eutonina, Aglantha*) support this suggestion.

R. KÄNDLER

Quantitative Fishing of Demersal Fish with the Standard Trawl

(Table 14)

The trawling experiments were carried out at the same stations in the Kiel Bay as in previous years; on 6. February and 2.—10. May by R.V. "Hermann Wattenberg", on 9.—12. October by means of a commercial fishing vessel. The results concerning the length and age distribution of flatfish are shown in Table 14.

The data are based in February on 4 hauls, in May on 15 hauls, in October on 10 hauls. The results of trawling differ very much with regard to place and season, showing that the fish are not uniformly distributed over the whole area, but accumulate at distinct places for feeding or spawning.

Plaice

The 1959 year-class (age-group I/II) dominated in the catches, but the quantity was not so high as expected, and decreased in the course of the year to a small amount in October. These decreasing catches per unit effort do not reflect in any way the abundance of the rich 1959 year-class and its influence on the commercial plaice fishery in the western Baltic which yielded 662 tons in 1961, i. e. sixfold the average of the years 1950/59 (113 tons). The increased landings and the larger quantities of plaice eggs spawned in 1961, may be taken as signs of the recovery of the plaice stock in the western Baltic which has been expected for many

Table 14. Length and age distribution of flatfish taken with the standard trawl in the Kiel Bay in 1961

Number in 1 hour's fishing

	Plaice			Dab			Flounder	
Length, cm	Feb.	May	Oct.	Feb.	May	Oct.	Feb.	May
6–10	0.2	—	—	1.0	0.6	0.2	1.0	—
11–15	—	0.1	—	17.2	5.8	0.6	4.8	—
16–20	2.8	1.3	0.1	23.0	14.3	3.0	1.6	—
21–25	17.2	4.3	—	18.8	12.5	3.3	0.8	0.1
26–30	8.0	5.6	0.6	5.8	5.2	0.7	0.6	0.7
31–35	0.8	1.0	0.4	0.8	1.1	—	—	0.2
36–40	0.2	0.1	0.1	—	—	—	—	0.1
41–45	0.2	—	—	—	—	—	—	—
Year-class								
1961	—	—	—	—	—	0.2	—	—
1960	0.2	—	0.1	0.8	0.5	1.7	—	—
1959	23.0	11.1	1.1	32.2	12.4	4.0	0.4	0.2
1958	5.4	1.3	—	28.4	19.5	1.8	5.0	0.2
1957	0.8	—	—	4.2	5.3	0.1	1.6	0.5
1956 and older	—	—	—	1.0	1.8	—	1.8	0.2
Total	29.4	12.4	1.2	66.6	39.5	7.8	8.8	1.1
Number examined	147	177	12	333	566	78	44	15

years. Obviously the unusual warm summer of 1959 was very favourable to the development of the brood of plaice.

Dab

The catches of this species were inferior to those in the preceding years and decreased nearly to the same extent in the course of the year as for the plaice. The 1959 year-class (age-group I/II) did not reach so high figures as the preceding 1958 year-class in 1960 as II-group, and proved to be poor, in contrast to the rich 1959 year-class of plaice. The unusually small catches of dab in October, like those of plaice, are striking and suggest that the main feeding grounds of these species were not encountered while fishing with the standard trawl.

Flounder

The latter observations are especially valid for the flounder which is caught during the winter in deeper water only. The catches per unit effort are always very low and do not reflect the commercial importance of this species.

R. KÄNDLER

Danish Investigations of 0- and I-Group Flatfish in Coastal Waters in 1961

(Table 15)

As in previous years the investigations were carried out by means of the Johansen young-plaice trawl operated at between $^3/_4$ and 2 m depth. Since 1957 an iron chain has been fitted at the footrope, and the figures in Table 15 have been corrected accordingly. The use of an iron chain has great advantage over the previously used lead, as the footrope will follow the bottom more closely.

From Table 15 it is seen that the abundance of the 1960 year-class of *plaice* in each of the water bodies investigated was very low. The number of I-group plaice in the Belts was twice that of the normal figure, although the abundance of 0-group fish was below normal strength in 1960. The abundance of I-group plaice found along the coastline is a rather unreliable measure of the frequency of a year-class. Thus in some previous years the abundance of the I-group has not corresponded to the frequency of the 0-group in the foregoing year.

Table 15. Numbers of 0-group and I-group plaice and flounder caught per hour with the Johansen young-plaice trawl in July/August 1961

(Preliminary figures; in parentheses long-period means)

	Number of stations	Plaice 0-group	Plaice I-group	Flounder 0-group	Flounder I-group
Belts	50	7 (28)	6 (3)	1	0.5
Sound ...	20	1 (17)	0 (2)	14	12
Western Baltic ..	7	1 (14)	0.2 –	0	0

The numbers of 0- and I-group *flounder* were very low in the Belts, but in the Sound relatively great numbers were encountered. As usual they were found only in the southernmost part of the Sound, the Køge Bay.

0-group *turbot* were completely absent along the coasts investigated, and of *brill* and *sole* only very few specimens were found.

AAGE J. C. JENSEN

Characteristics of the Plaice (*Pleuronectes platessa* L.) in the southern Baltic in the Season 1960/1961

(Tables 16–17)

The percentages of plaice in the flatfish catches in the season 1960/61 were as follows:—

Gdansk Bay	2.7%
Bornholm Basin	27.6%
Pomeranian Bay	77.3%

Table 16. Age composition (%) of the Polish plaice catches in 1960/1961

Age-groups	II		III		IV		V		VI		VII		VIII+		Total
Sex	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	
Pomeranian Bay															
1961	2.3	2.8	23.0	34.5	8.9	26.5	0.1	1.8	—	0.1	—	—	—	—	100
♂ × ♀	5.1		57.5		35.4		1.9		0.1		—		—		100
Bornholm Basin															
1960	—	—	7.4	0.7	24.2	6.3	12.9	17.7	2.8	13.8	0.9	8.8	0.1	4.4	100
♂ + ♀	—		8.1		30.5		30.6		16.6		9.7		4.5		100
1961	—	—	7.5	1.1	21.1	7.2	12.2	10.0	3.6	8.9	2.8	16.7	—	8.9	100
♂ + ♀	—		8.6		28.3		22.2		12.5		19.5		8.9		100
Gdansk Bay															
1960	—	—	5.2	2.6	15.2	15.2	12.5	21.6	1.7	18.6	—	5.2	—	2.2	100
♂ + ♀	—		7.8		30.4		34.1		20.3		5.2		2.2		100
1961	—	—	6.9	6.9	24.2	3.5	17.2	17.2	—	13.8	—	10.3	—	—	100
♂ + ♀	—		13.8		27.7		34.4		13.8		10.3		—		100

Table 17. Mean lengths of plaice in 1960/1961

Region	Year	Age-groups II	III	IV	V	VI	VII	VIII+
Pomeranian Bay	1961	22.4	24.7	27.4	30.3	32.0	—	—
Bornholm Basin	1960	—	23.0	25.7	28.9	32.0	35.1	39.5
Bornholm Basin	1961	—	24.5	26.7	30.1	32.8	35.7	38.9
Gdansk Bay	1960	—	23.9	26.5	29.7	32.1	35.2	38.6
Gdansk Bay	1961	—	20.8	26.5	30.1	32.8	35.7	—

In the region of the Pomeranian Bay, which is the feeding ground for flatfish, the plaice caught there were between 21 cm and 32 cm in length with a mean length of 25.6 cm. In the Gdansk region the length range was from 19 cm to 42 cm, the mean being 29.2 cm. In the Bornholm Basin the lengths were between 21 cm and 47 cm, with a mean length of 29.5 cm.

The age composition of the plaice in the particular regions in 1961, as compared with 1960, is presented in Table 16. In the Pomeranian Bay, the II- and III-groups constituted 62.6% of the total. Older age-groups were caught in Bornholm Basin. In 1960 the IV- and V-groups constituted 61.1% of the total catches in this region; in 1961, however, the same groups were slightly less numerous, constituting only 50.5% of the catches. The IV- and V-groups dominated also in Gdansk Bay, constituting 64.5% of the catches in 1960 and 62.1% in 1961. The average length of the different age-groups is presented in Table 17.

The condition coefficients calculated on the basis of length measurements of plaice in maturity stages II and III were as follows:—

Region	1960	1961
Pomeranian Bay ...	—	1.067
Bornholm Basin	1.111	1.161
Gdansk Bay	1.285	1.128

Z. Reimann

The Polish Flounder Fishery in the Baltic during 1961

(Table 18)

The Polish flatfish catches in the Baltic in 1961 reached an unusually high level, amounting to 2,157 tons, in comparison with an average for the last 10 years of only 1,150 tons. The steady increase of the yearly landings has been observed since 1959, after the poor year of 1958 when the flatfish catches only amounted to 948 tons. The experimental fishing with the standard trawl in Gdansk Bay in the autumn of 1961 yielded also relatively good catches of flatfish.

As usual, the flounder predominated in Gdansk Bay providing 97%. In the Bornholm Basin the flounder constituted 71% of the flatfish catches, whereas in the coastal waters of the Pomeranian Bay (Odra Estuary) it provided only 22% of these catches. In the latter region plaice is predominant, constituting 77% of the flatfish catches.

The length composition of the flounder catches taken by trawl in 1961 is given in Table 18.

The length of the flounder in Gdansk Bay oscillated between 18 cm and 42 cm with an annual mean length of 25.9 cm (in 1960 18—46 cm, mean 26.9 cm). In Bornholm Basin it ranged between 20 cm and 45 cm with a mean of 26.8 cm (in 1960 20—45 cm, mean 27.6 cm). The mean length of the flounder caught in 1961 is about 1 cm lower than that of 1960.

Age-groups III and IV were predominant in the catches.

It is worth mentioning that in 1961 a relatively high number of flatfish fry was taken per hour with the hand push-net in the coastal waters.

W. Cieglewicz

Some Data about the Baltic Lavaret in the Pomeranian Bay

(Table 19)

A year to year increase in the number of Baltic lavaret (*Coregonus lavaretus lavaretus* L.) in the Pomeranian Bay has been observed for several years. This species inhabits the near-coastal Baltic waters and spawns in the Firth of Szczecin and Lower Odra.

The numerical increase of this stock is evidenced

Table 18. Length composition (%) of the Polish flounder catches

Region	No. of fish	Length in cm 18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35+	Mean length
Gdansk Bay	1,703	1.7	3.3	4.5	4.0	6.2	8.5	7.8	10.9	11.5	10.4	7.9	6.2	5.5	3.2	1.9	1.9	1.6	3.0	25.9
Bornholm Basin ..	1,158	—		0.3	1.3	3.7	8.0	11.1	15.2	12.8	11.7	10.2	7.2	6.1	4.6	2.7	1.2	1.7	2.2	26.8

Table 19. Length and weight composition of the lavaret

(Data from 1956/57)

Age-group	I	II	III	IV	V	VI	VII	
Mean length, cm	26.2	38.0	42.9	46.2	50.2	53.7	60.0	
Mean weight, g	186	536	752	956	1,141	1,459	1,830	
Number of measurements	97	26	23	22	21	9	1	Total 234

by the increase of the catches. Before the Second World War an average of 1,348 kg of lavaret was caught in the whole Firth of Szczecin. Unfortunately no statistics of the catches in the Pomeranian Bay in that period is available. However, in the first post-war years the lavaret was only found sporadically both in Baltic waters and in the Firth. Not until 1954/56 did it begin to appear more and more numerously. In the coastal waters of the Baltic in the Rewal/Swinoujscie section 800 kg were caught in 1954 and 1,384 kg in 1956. The catches of the German Democratic Republic during the years 1954 to 1957 were between 643 and 1,016 kg. In 1960 the fishery in the German waters yielded 3,800 kg, and in the Polish waters about 10,000 kg; in 1961 the catches in the latter waters exceeded 25,000 kg.

It should be stressed that protection of the lavaret was enforced in the Polish fisheries (total prohibition of fishery) in the years 1949 to 1959, but from 1960 the protection was limited to the spawning grounds and some protective measures. The fry campaign was started in 1955; almost each year from 10,000 to 100,000 fingerlings of lavaret were liberated into the Firth of Szczecin. Both these efforts have no doubt influenced the regeneration of the lavaret; the fish itself displays adequate biological features of regeneration.

A brief description of the biological characteristics is given below.

The life cycle of the lavaret is comparatively short; only in exceptional cases it becomes more than 7 years old. It grows rapidly, particularly in the first three years. The growth-rate of the lavaret is presented in Table 19.

The increase in weight is almost equal throughout the life of the lavaret. The length increment decreases from the third year, although it is the highest in the Pomeranian Bay lavaret as compared with all the other lavaret found in Polish waters.

The lavaret is usually mature at the age of 3+ and from that moment the growth-rate decreases. The sex ratio is balanced at 1 : 1. The fecundity is very high.

The fish enter fresh water for spawning; they are accompanied on the spawning migration by a part of the juvenile fish. The spawning migration starts in October. One part of the stock spawns on the spawning grounds of the Firth of Szczecin, another as far as the Lower Odra. Spawning begins in the second half of November and lasts 2—3 weeks depending on the atmospheric conditions. When the temperature drops to 4°—3°C the spawning process is either interrupted or over. When the spawning is finished the majority of the fish spends the winter in the Firth and returns to the sea in spring; some of the fish, however, return to the sea immediately. The lavaret keep farther away from the coastal area in summer; the rest of the year they remain in the coastal water.

The recovery of the spents is a long process, taking about 5 months, but in summer the ovaries are big enough to fill up a greater part of the body cavity. From about 20 cm in length the sex of the juvenile fish may be distinguished macroscropically. These individuals will spawn for the first time at 1.5 or 2.5 years.

The most important food of the lavaret is the crustacean *Neomysis vulgaris*; it was found in the stomachs of 61% of the fish examined. The maximum number found in the stomach of one lavaret was over 600 specimens. In winter the larger fish (over 30 cm in length) in the Firth of Szczecin and in the canals feed on *Osmerus eperlanus* (smelt), and in the Pomeranian Bay they feed on *Gobius* sp. The younger fish are satisfied with *Neomysis vulgaris*, which are not too numerous in winter, so they are often starving. In the spawning period the mature fish take no food. The size of their stomachs shrink and the tissues become thick and stiff.

The Pomeranian Bay lavaret can be successfully used for fry liberation. The spawners can be kept in live-boxes for some weeks. The mature individuals are easily caught and the sexual products are easy to obtain.

The percentage of artifical fertilization is very high (about 90%) and so is that of hatching. The breeding of fry in ponds gives excellent results. In autumn the I-group lavaret measure from 11 to 25 cm in length, depending on the weather conditions throughout the warm season.

A. Peczalska

D. Atlantic Area

Fishes from the Central North Atlantic

From April to June the R.V. "Anton Dohrn" was operating in the central North Atlantic with the objectives to study the distribution and abundance of redfish larvae in this area. At this occasion some hauls with the Isaacs-Kidd midwater trawl and another floating trawl were effectuated in order to obtain adult and pelagically living redfish from the open ocean. These catches provided no redfish but a rather great number of divers pelagic — mostly bathypelagic — fishes which are listed below, together with some other fish caught by the Nansen net.

The Isaacs-Kidd midwater trawl (IKMT) was towed at a depth of about 450 m for 60 minutes at a speed of 4 sm./h. The other floating trawl was fishing each 30 minutes in 4 to 5 different horizons, and was towed at a speed of 4—6 sm./h.

If not stated otherwise the fish length is given in total length as well as in standard length (both values are separeted by a "/").

Stat. no. 511/61, 56°39′N, 42°00′W—56°50′N, 42°00′W To = 4.7°C; T_{300} = 3.6°C.
10. 5. 1961 18.50^h—22.10^h Floating Trawl (50, 100, 150, 200 and 250 m).
1 *Cyclopterus lumpus* L.; about 35cm. Brought home alive; not measured.

Stat. no. 528/61, 57°02′N, 34°21′W—57°09′N, 34°12′W. To = 7.3°C, T_{300} = 6.1°C.
13. 5. 1961 10.00^h—12.45^h Floating Trawl (200, 300, 350 and 400 m).
1 *Nansenia groenlandica* (Reinhardt 1839); 134/122 mm.

Stat. no. 534/61, 58°07′N, 32°05′W.
14. 5. 1961 To = 7.6°C; T_{75} = 6.9°C.
02.20^h—02.30^h Nansen Net (75—0 m).
1 *Stomias boa ferrox* Reinhardt 1842; 107/100 mm (fish lived for 3 days).

Stat. no. 543/61, 57°51′N, 28°28′W.
15. 5. 1961 To = 8.4°C; T_{75} = 7.7°C.
02.15^h—02.30^h Nansen Net (75—0 m).
1 *Benthosema glaciale* (Reinhardt 1837); 24/21 mm.

Stat. no. 551/61, 56°57′N, 25°33′W.
15. 5. 1961 To = 9.4°C; T_{400} = 7.1°C.
21.15^h—22.45^h Isaacs-Kidd midwater trawl (450 m).
5 *Argyropelecus olfersi* Cuvier 1829; 43/33, 47/38, 48/37, —/38, and 52/40 mm.
59 *Benthosema glaciale* (Reinhardt 1837); 32 of them were damaged and could not be measured.

Standard length:	24	25	26	27	28	29	30 mm
Number:	1	4	—	2	4	2	2
Standard length:	31	32	33	34	35	36	37 mm
Number:	—	1	2	—	1	5	1
Standard length:	38	39	40 mm				
Number:	1	—	1				

4 *Notoscopelus elongatus* (Costa 1844) = *Notoscopelus kröyeri* (Malm 1863) /123, —/130, —/134, and —/135 mm.

Stat. no. 559/61, 60°00′N, 23°00′W—60°07′N, 22°58′W. To = 9.7°C; T_{400} = 8.3°C.
16./17. 5. 1961 22.35^h—01.15^h Floating Trawl (200, 300, 350, and 400 m).
2 *Holbyrnia* (*Krefftia*) *schnakenbecki* (Krefft 1953); —/99 and —/143 mm.
1 *Searsia koefoedi* Parr 1937; —/114 mm.
20 *Bathylagus* sp.; 51, 64, 74, 75, 77, 85, 88, 88, 89, 90, 91, 91, 96, 98, 101, 103, 109, 113, 114, and 117 mm standard length.
1 *Nansenia groenlandica* (Reinhardt 1839); damaged, not to be measured.
1 *Mallotus villosus* (O. F. Müller 1776); 117/104 mm.
1 *Argyropelecus olfersi* Cuvier 1829; —/32 mm.
1 *Chauliodus sloanei sloanei* Schneider 1801; 137/130 mm.
3 *Electrona* (*E*) *rissoi* (Cocco 1829); 60/53, 64/58, and 68/60 mm.
18 *Lampanyctus crocodilus* (Risso 1810); 109/94, 112/95, 113/99, 116/100, 119/101, 120/103, 122/104, 125/103, 125/106, 127/110, 128/108, 130/106, 130/109, 130/111, 131/112, 145/121, and 165/142 mm.
13 *Notoscopelus elongatus* (Costa 1844) = *Notoscopelus kröyeri* (Malm 1863); 135/113, 135/113, 139/118, 148/124, 149/126, 150/125, 150/125, 153/127, 153/128, 155/128, 155/132, 156/131, 162/134 mm.
1 *Serrivomer* sp.; 39 cm total length.
64 *Melamphaes* sp.; 51/42, 52/43, 52/43, 53/43, 55/46, 59/46, 62/50, 63/52, 63/54, 66/54, 66/55, 66/56, 69/54, 69/58, 70/54, 70/56, 70/57, 70/57, 71/59, 71/60, 72/58, 72/59,

73/58, 74/58, 74/59, 74/61, 74/62, 74/62, 75/60, 75/61, 75/62, 76/62, 76/62, 76/62, 77/59, 77/62, 77/63, 78/62, 79/64, 79/64, 80/64, 80/66, 81/63, 81/63, 81/63, 81/63, 82/66, 82/67, 83/66, 83/67, 83/68, 84/66, 84/69, 75/70, 86/70, 86/70, 87/74, 91/73, 93/76, 94/74, 95/78, 95/78, 96/79, and —/81 mm.

Stat. no. 579/61, 60°00'N, 19°38'W—60°03'N, 19°35'W. $T_0 = 9.9$°C, $T_{400} = 8.2$°C.

22./23. 5. 61 23.45^h—01.25^h Isaacs-Kidd midwater trawl (450 m).

1 *Bathylagus* sp.; 36/33 mm.

17 *Argyropelecus hemigymnus* Cocco 1827; 18, 19, 19, 19, 19, 19, 19, 20, 20, 23, 24, 25, 28, 30, 31, 32, and 32 mm standard length.

2 *Argyropelecus olfersi* Cuvier 1829; 42/35 and 48/38 mm.

Maurolicus mülleri (Gmelin 1789); only fragments of some specimens, identified by Dr. G. Krefft

2 *Stomias boa ferrox* Reinhardt 1842; only fragments, identified by Dr. G. Krefft.

19 *Electrona* (*H*) *arctica* (Lütken 1892); 29/24, 34/29, 34/30, 35/29, 35/30, 36/31 mm + 13 damaged specimens which could not be measured.

Adolf Kotthaus

Gadoid Fish

INTRODUCTION

Contributions to this report have been received from the following: —

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M. A. Sonina

Ulrich Schmidt

YOUNG STAGES

Cod Fry and Small Cod in Coastal Waters and on the Offshore Banks of West Greenland in 1961

(Figure 1)

Occurrence of cod eggs and larvae

As in the two previous years, cod eggs were scarce in the catches taken in the Godthåb Fjord with the 1 m stramin net in 30 min. hauls with 100—50 m of wire out. Hauls were made in January, February, March, April, and May. The first cod eggs were caught on 22. March in the inner part of the fjord, but in small numbers only. The best catch was 150 eggs. In the middle and last part of May cod eggs were more numerous. In two catches, 1,870 and 1,427 cod eggs respectively were taken.

Investigations on the occurrence of cod eggs and larvae over Fylla Bank were carried out on 24. April and 27. June. On each date 30 min. hauls with the 1 m stramin net and 100—50 m of wire out were made at three stations, viz. (1) between the shore and the bank; (2) over Fylla Bank; (3) on the western slope of Fylla Bank.

The results were as follows (number of larvae in parenthesis): —

Station	1	2	3
24. April	79 (0)	1 (0)	787 (0)
27. June	0 (22)	0 (14)	0 (0)

At Station 3, 441 cod eggs and 1 larva were taken on 24. April in a haul with 300 m of wire out.

Figure 1 shows the catches of cod larvae taken with a 2 m stramin net by "Dana" in July. The numbers of cod larvae in the catches in Davis Strait were very small. The highest numbers were 26 larvae taken on 26. July in two hauls with 100—25 m of wire out far west of Fylla Bank (63°43'N, 58°42'W and 64°24'N, 58°37'W). In a haul on 28. July (66°17'N, 54°29'W) with 100—25 m wire, 25 cod larvae were caught. At all the other stations except two, the numbers of cod larvae were below 10. The reason for the poor catches may be ascribed to the exceptionally large size of the larvae in July 1961; more than 66% were larger than 20 mm. Probably many of the largest larvae have escaped from the gear. Owing to this fact it is impossible to evaluate the strength of the 1961 year-class.

Occurrence of age-groups I, II, and III

Only two samples of small cod were collected in 1961. One sample (64 fish) was taken with shrimp trawl in the coastal area south of Godthåb (1 D) on 10. February. The sample contained practically only one single age-group, namely the III-group (1958 year-class). The other sample was taken with hand seine from the shore near Godthåb (1 D). This sample contained 771 small cod. The length frequencies show that the two age-groups I and II (1960 and 1959 year-classes) are represented in equal numbers.

In all subdivisions only a few small cod were seen close to the shore in the coastal region. The only exception was Christianshåb Harbour (1 B), where large shoals of small cod occurred in July and August feeding on discards from the shrimp plant. From the size of these small cod it was

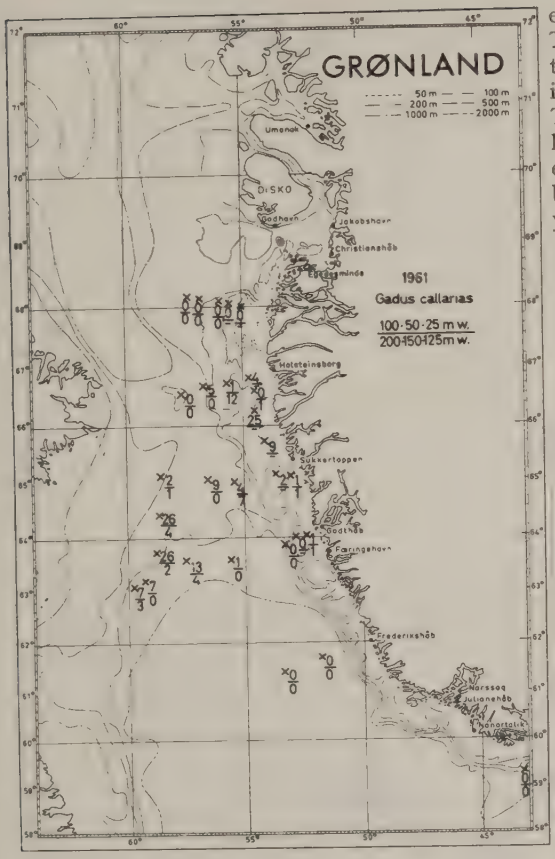

Figure 1. Numbers of cod larvae caught with the 2 m stramin net in 30 min. hauls. 100–50–25 and 200–150-125 m of wire out.

easy to distinguish three age-groups: I, II, and III. The I-group was found in shallow water close to the shore, while the II- and III-groups occurred in deeper water at some distance from the shore. The II-group was found in the middle of the harbour and the III-group farther out near the entrance to the harbour. This phenomenon has been observed in Christianshåb Harbour every year since the shrimp plant was built.

P. M. Hansen

Soviet Investigations on Young Cod in the Barents Sea

(Figure 2; Tables 1–3)

Surveys of young cod were carried out from the R.V. "Tunetz" and the scouting trawler "Melitopol" in the autumn/winter period of 1960/61. The results of the trawlings carried out with the research vessels "Persey-II" and "Balaklava" in the southern Barents Sea have also been considered. As in previous years, the gear used was a 25 m bottom trawl with covered cod-end and a mesh size of 10 mm between the knots.

Southern area

The results of the survey are shown in Table 1. Young cod up to 36 cm in length averaged 37 specimens per hour's trawling, i.e. the same number as in the winter of 1959/60 (36 specimens). In the winter of 1960/61, the 1958 year-class was predominant in the catches (39.6%). The 1959 year-class provided the lowest numbers. Small cod of that brood were distributed rather evenly over the southern part of the sea, except to the north-east where they were scarce. Relatively large numbers were found in the Motovsky Bay.

Table 1. Mean number of young cod of different ages caught per hour's trawling in the southern Barents Sea

Area	Month of sampling	Number of hauls	Age and year-class 0+ (1) 1960	1+ (2) 1959	2+ (3) 1958	3+ (4)[1] 1957	Total	Total number of fish
Central	Oct.–Dec.	108	9	6	27	21	64	6,987
Western	Oct.–Jan.	84	10	3	4	4	22	1,922
Coastal	Oct.–Dec.	27	5	5	8	6	25	699
Eastern	Oct.–Nov.	41	2	7	22	5	37	1,513
North-eastern	Oct.–Dec.	38	1	1	4	2	8	315
Central Knoll	Oct.–Jan.	27	10	7	5	5	28	758
Total	Oct.–Jan.	325	7	4	14	10	37	12,194
% of total			19.6	13.2	39.6	27.6		
Motovsky Bay	Oct.	4	11	22	4	5	42	166
% of total			27.7	51.7	9.2	11.4		

[1]) This group includes only specimens below 36 cm in length.

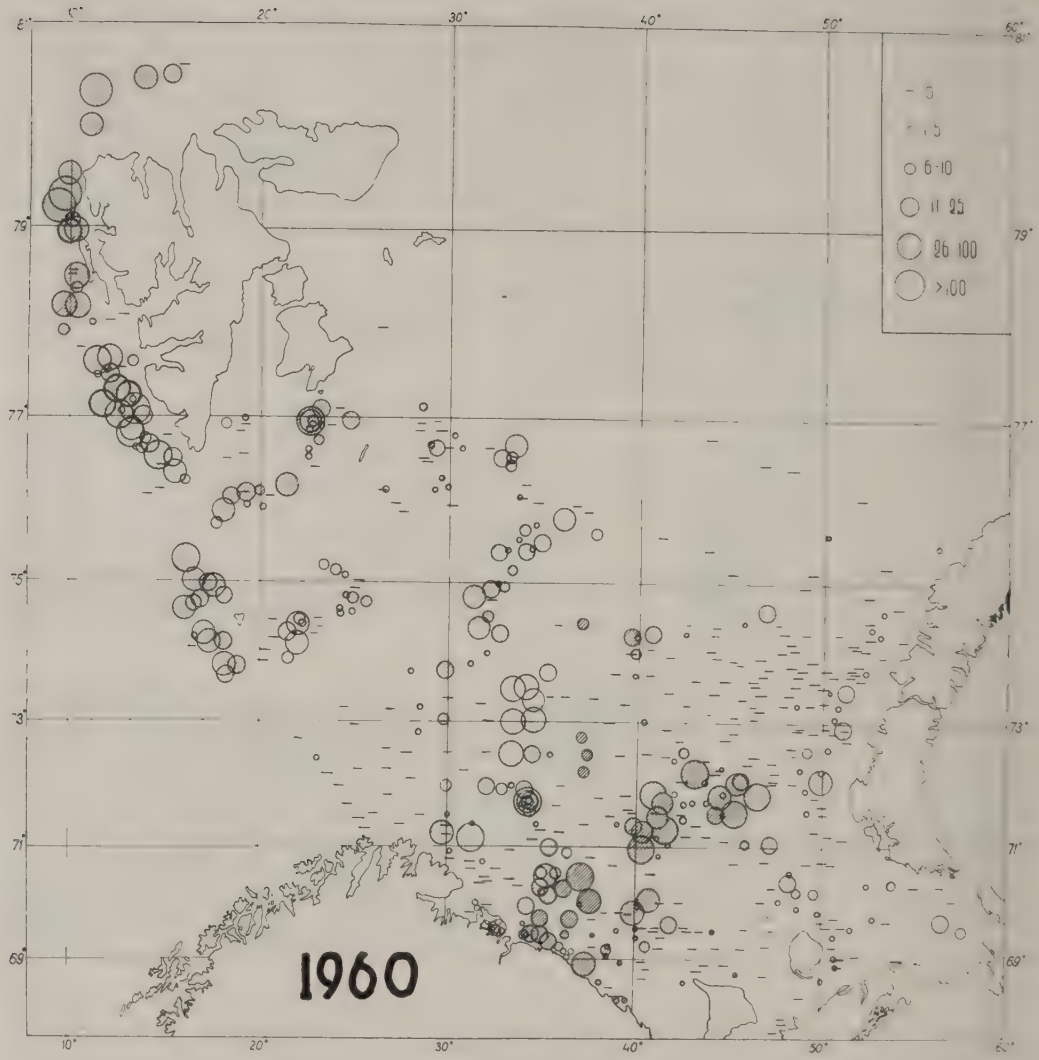

Figure 2. Distribution of 0-group cod in the Barents Sea.

The 0-group was unevenly distributed over the areas (Fig. 2). A higher average yield per hour's trawling was obtained in the western part and on the Central Knoll, but in the central area the yields were lower. The occurrence of 0-group cod in the inshore waters was very poor.

In the eastern and north-eastern areas the numbers of 0-group cod were the poorest.

In the southern part of the area the average catch of 0-group cod was lower in the winter of 1960/61 than in 1959/60. Only in the western part and in Motovsky Bay the average catch of 0-group fish (1960 year-class) was higher than in 1959.

Comparison of the 1960/61 data with the long-term data (Table 2) shows that for the southern area the 1957 and 1958 year-classes are of medium strength. According to the evaluation of 0- and I-group cod, the strength of the 1959 year-class is not above average. The indices for the 1960 year-class are still lower than those for the 1959 class.

Table 2. Mean number of 1–4 year-old cod caught per hour's trawling in the southern Barents Sea during the winter season

Year-classes	1 year-old	2 year-old	3 year-old	4 year-old	Mean catch of 2 and 3 year-olds
1946	< 1	2	7	8	5
1947	2	8	23	5	17
1948	18	28	21	31	25
1949	5	14	34	26	24
1950	14	89	77	70	82
1951	16	20	8	3	13
1952	1	1	3	2	2
1953	4	11	11	4	11
1954	30	14	6	15	10
1955	7	1	9	2	4
1956	12	15	9	6	12
1957	31	4	11	10	10
1958	11	8	14	4	10
1959	11	4	—	—	-
Long-term mean excl. 1950 year-class	11	10	12	9	11
1960	7				

North-western areas

In these parts of the sea, young cod were twice as plentiful as in the southern areas. Cod of the 1960 year-class were much more numerous (approx. ×3). The 0-group was especially rich in the waters of West and North Spitsbergen and on the western slope of the Bear Island Bank. The occurrence of such high numbers of 0-group cod in these areas testifies to a significant drift in 1960 of fry from the spawning grounds along the Spitsbergen branch of the Norwegian Current.

Regular evaluation of the stock of young fish in the north-western areas have been undertaken since 1958. As yet it is impossible to compare the abundance of these areas with those of the southern area. However, according to the results obtained for the southern part of the sea, the 1960, 1959, 1958, and 1957 year-classes in the north-western part of the sea will not be below average.

According to the average numbers taken per hour's trawling of the 1960 and 1958 year-classes they may even be evaluated as good. Especially large numbers of the 1958 year-class were obtained in the South Cape Gully (Table 3).

A. S. Baranenkova

Soviet Investigations on Young Haddock in the Barents Sea

(Figure 3; Tables 4–6)

Southern areas

As in previous years, surveys of young haddock were carried out during the winter of 1960/61. The results of the survey in the southern Barents Sea are shown in Table 4. It was revealed that in the winter of 1960/61 young haddock were more numerous than in winter 1959/60. In the central, coastal, and western areas the average catch of young haddock (up to 36 cm long) per hour's trawling amounted to 51 fish in 1960/61 against 33 fish caught in the same areas in 1959/60. In that season the average catch of young haddock was the lowest for the last seven years. The increased catches of young haddock in 1960/61 was mainly due to the abundance of 0-group fish, thus testifying to the fact that the brood of 1960 was good. The greatest numbers of young

Table 3. Mean number of young cod caught per hour's trawling in the north-western Barents Sea from October to December 1960

Areas	Month of sampling	Number of hauls	Age and year-classes 0+ (1) 1960	1+ (2) 1959	2+ (3) 1958	3+ (4)[1] 1957	Total	Total number of fish
Bear Island								
Southern slope	Nov.	18	14	19	17	8	58	1,050
Eastern slope	Nov.	18	5	23	29	24	81	1,455
Western slope	Nov.	15	35	13	11	8	67	991
Total		51	17	18	19	14	68	3,496
% of total			24.7	26.8	28.6	19.9		
North Spitsbergen	Oct.	5	39	3	17	<1	59	297
West Spitsbergen	Oct.–Nov.[1]	49	66	9	14	2	91	4,488
South Cape Gully	Oct.–Nov.	37	14	14	60	47	135	4,984
Hopen Island	Oct.–Nov.[1]	19	1	4	11	6	23	443
Persey Elevation	Oct.–Dec.	14	6	2	3	2	13	176
Total of all areas	Oct.–Nov.	175	29	11	24	15	79	13,884
% of total			35.7	14.6	30.6	19.1		

[1]) This group includes only specimens below 36 cm in length.

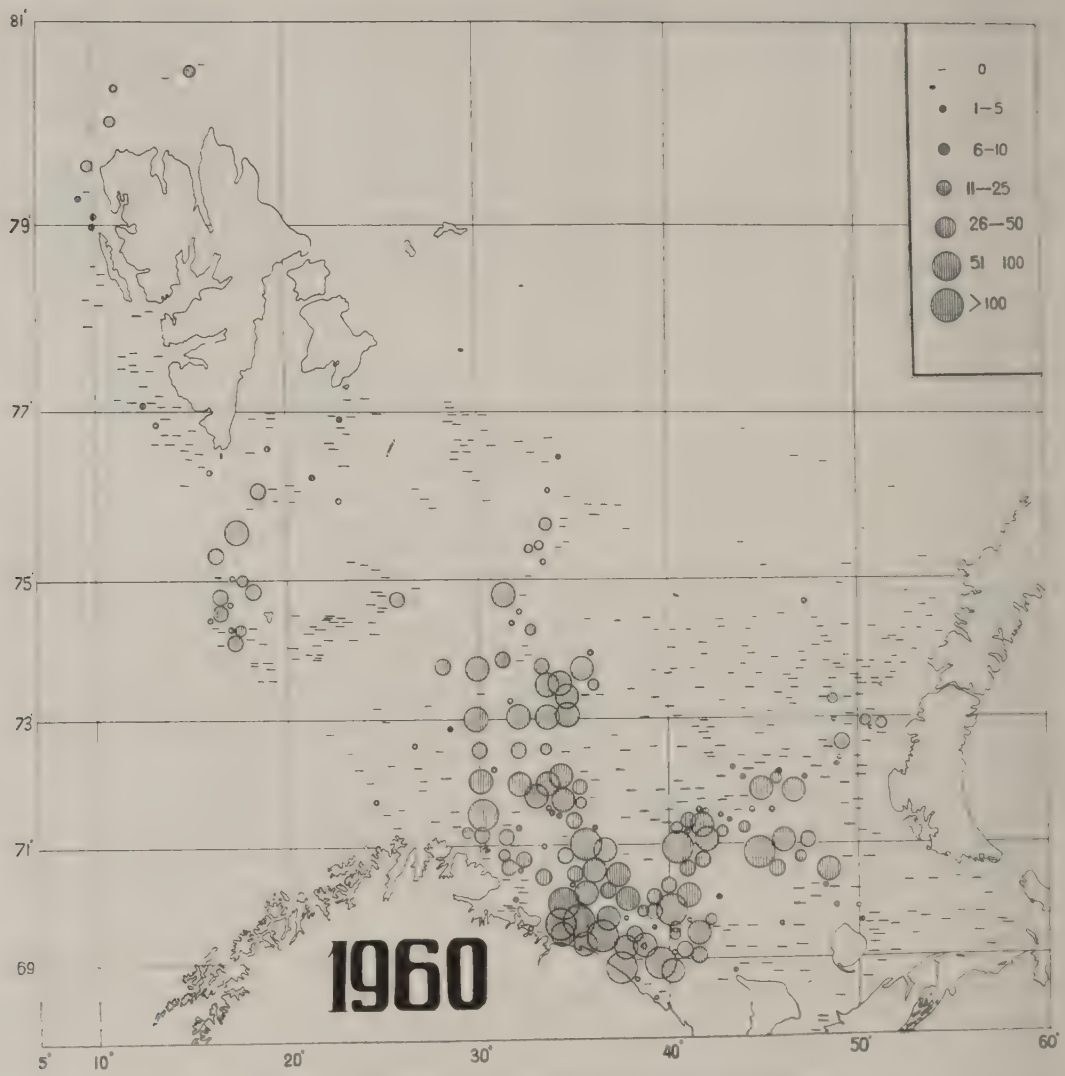

Figure 3. Distribution of 0-group haddock in the Barents Sea.

haddock were observed in the coastal areas, lower numbers in the western part, and lowest in the central region. Contrary to the previous year, haddock were scarce on the Central Knoll and in Motovsky Bay. In the eastern and north-eastern areas the 0-group occurred only occasionally in the trawls.

In general, the distribution of the 1960 year-class (Fig. 3) resembles that of the 1959 year-class with the difference that the 1960 brood was distributed over extensive areas to the east, north-east, and north. 0-group haddock occurred in poor numbers in the Central Knoll area.

According to the data obtained for the 1959 year-class as 0-group (Table 5) it was evaluated to be below medium. Data obtained in the winter of 1960/61 show, however, that this year-class is of medium strength. The prognosis of the 1958 year-class as being poor was confirmed by the data collected in 1960/61.

Table 4. Mean number of young haddock of different ages caught per hour's trawling in the southern Barents Sea

Areas	Month of sampling	Number of hauls	Age and year-class 0+ (1) 1960	1+ (2) 1959	2+ (3) 1958	3+ (4) 1957	Total	Total number of fish
Central	Oct.–Dec.	108	19	5	1	< 1	26	2,805
Western	Oct.–Jan.	84	24	15	4	< 1	44	3,712
Coastal	Oct.–Dec.	27	94	44	22	13	173	4,681
Total	Oct.–Jan.	219	30	14	5	2	51	11,198
% of total			59.3	26.9	10.1	3.8		
Motovsky Bay	Oct.	4	1	3	2	< 1	6	24
% of total			8.3	58.3	29.2	4.2		
Eastern	Oct.–Nov.	41	1	—	—	—	1	63
North-eastern	Oct.–Dec.	38	< 1	—	—	—	< 1	1
Central Knoll	Oct.–Jan.	27	3	< 1	< 1	—	3	91

Table 5. Mean number of 1—4 year-old haddock of different year-classes caught per hour's trawling in the western, central, and coastal areas of the Barents Sea during the autumn/winter of 1960/61

Year-class	1 year-old	2 year-old	3 year-old	4 year-old	Mean of 2 and 3 year-olds
1946	<1	—	1	3	1
1947	—	<1	1	<1	1
1948	5	32	26	13	30
1949	3	1	11	2	7
1950	80	247	262	87	256
1951	22	19	12	12	15
1952	8	5	10	4	7
1953	11	40	25	10	31
1954	10	7	3	3	5
1955	8	3	2	3	3
1956	26	18	27	8	23
1957	38	9	14	—	12
1958	2	4	5	—	4
1959	7	14	—	—	—
Long-term mean, 1950 excluded	11	11	12	6	12
1960	30				

Table 6. Mean number of young haddock of different ages caught per hour's trawling in the north-western areas of the Barents Sea

Areas	Month of sampling	Number of hauls	Age and year-class 0+ (1) 1960	1+ (2) 1959	2+ (3) 1958	3+ (4)[1] 1957	Total	Total number of fish
Bear Island								
Southern slope	Nov.	18	—	<1	—	—	<1	3
Eastern slope	Nov.	18	<1	—	-	—	<1	15
Western slope	Nov.	15	8	24	4	<1	37	561
Total		51	3	7	1	<1	11	579
% of total			23.2	62.9	11.7	2.2		
North Spitsbergen	Oct.	5	4	—	—	—	4	20
West Spitsbergen	Oct.–Nov.	49	<1	5	3	<1	8	378
South Cape Gully	Oct.–Nov.	37	1	<1	<1	—	2	94
Hopen Island	Oct.–Nov.	19	—	—	—	—	-	-
Persey Elevation	Oct.–Dec.	14	<1	-	—	—	<1	1
Total		175	1	3	1	<1	6	1,072
% of total			21.4	57.4	19.5	1.7		

[1]) This group includes only specimens below 36 cm in length.

The 1957 year-class is of medium strength. In the winter of 1960/61 this year-class, having a length of less than 36 cm, constituted 3.8% of the total number of young haddock; they stayed mainly in the inshore waters.

North-western areas

In these areas young haddock are less abundant than in the southern part of the sea (Table 6). It is noteworthy that the mean number of young haddock caught per hour's haul was somewhat greater in the autumn of 1960 than in autumn 1959. In both years the maximum concentrations of young haddock were observed on the western slope of the Bear Island Bank, in the West Spitsbergen area, and in the South Cape Gully. They consisted chiefly of the 1959 year-class. On the western slope of the Bear Island Bank the average catch of that brood was 11 specimens in autumn 1959 while in autumn 1960, 24 specimens were caught. These data confirm that in 1959 a considerable drift of larvae in the West Spitsbergen Current must have occurred.

Other year-classes were very poorly represented. The 1960 year-class was relatively more abundant. It was mainly found on the western slope of the Bear Island Bank. According to Mr. BERGER, the leader of the expedition of "Tunetz", single specimens belonging to the 0-group were found on 12—14. October 1960 beyond North Spitsbergen (see Fig. 3).

A. S. BARANENKOVA

COMMERCIAL FISH

COD

Greenland Stock

Cod Investigations in the Coastal Waters and on the Offshore Banks of West Greenland in 1961

(Figures 4–6)

Age composition

Offshore banks

Otoliths of 2,101 cod were collected from the offshore banks: 1,080 from long-line catches on Fylla Bank by the "Adolf Jensen" in April/July; 1,021 from hand-line catches by the "Dana" and "Adolf Jensen" in the period 17. July to 5. August on Store Hellefiske Bank, Lille Hellefiske Bank, Fylla Bank, and Dana Bank.

The age compositions and length frequencies are given in Figure 4. Large old cod belonging to the 1953 and 1947 year-classes predominated in the long-line catches.

In the two catches, No. 1 from the western slope of Fylla Bank, depth 270 m, and No. 2 from east of Fylla Bank, depth 80—170 m, the 1953 year-class predominated with about 60% and 30% respectively. Both catches were taken in April when spawning was almost over. The percentages of immature cod were 11.4% (No. 1) and 46.3% (No. 2). The smallest amount of immature fish were found in the catch from the western slope of Fylla Bank in the spawning area. Of the cod spawning this year 95.6% (No. 1) and 93.9% (No. 2) were spent and 4.4% (No. 1) and 6.1% (No. 2) had ripening milt or roe.

In sample No. 3, taken east of Fylla Bank in May, the 1953 year-class was still predominant but only with 19.4%; the second and third largest year-classes were 1957 (17.6%) and 1956 (15.4%).

In sample No. 4, west of Fylla Bank, 120—325 m, June, the old 1947 year-class predominated with 27.6%. The second best was the 1945 year-class with 13.1%, followed by the 1950 and 1953 year-classes, both with 12.2%.

Samples Nos. 5 and 6 are from catches taken on 17. and 21. July east of Fylla Bank, depth 75—130 m. In No. 5, taken on long-line, the 1947 year-class predominated with 23.6%, the 1953 year-class was represented with 17.9% and 1957 with 11.4%. Sample No. 6, a hand-line catch, is quite different in age composition from No. 5, although it was taken in the same place and depth. The 1957 and 1956 year-classes together make up about 75% of the sample; 1957 constitutes 52.2% of the sample.

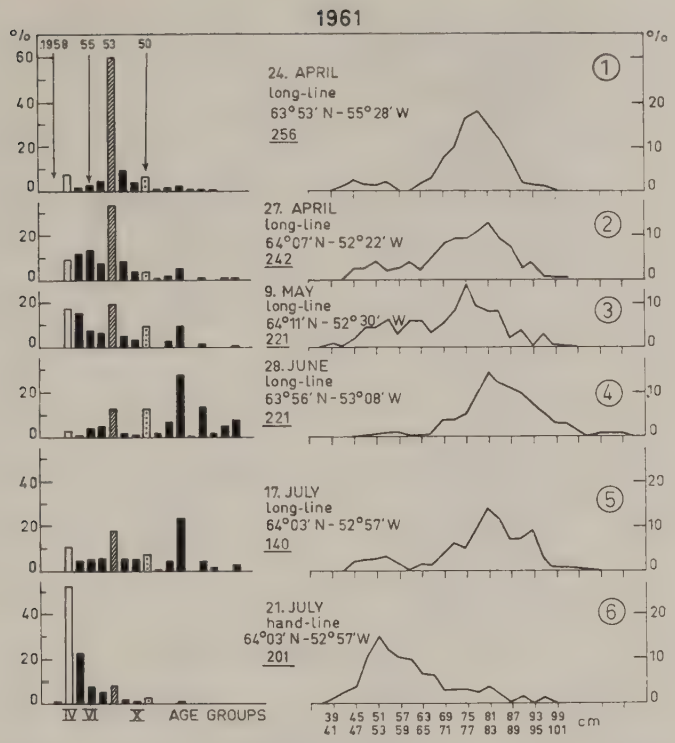

Figure 4. Percentage age and length distribution of cod from Fylla Bank.

The mean ages, lengths, and weights of cod from six samples were as follows:—

Sample Nos.	1	2	3	4	5	6
Mean age	8.3	7.7	8.0	12.7	9.9	5.2
Mean length (cm)	76.3	74.4	71.7	86.1	79.6	61.0
Mean weight (kg)	3.8	3.8	3.4	6.3	—	—

The age compositions and length frequencies of cod in hand-line catches from "Dana" are given in Figure 5. The 1957 year-class predominated strongly in the samples from the two northern banks, Store and Lille Hellefiske Banks. In sample No. 7, from the northern Store Hellefiske Bank (68°00'N), the 1957 year-class amounted to 81.2%, while it constituted 73.8% in sample No. 8 (66° 53'N). In the sample from Lille Hellefiske Bank the 1957 year-class was still predominant with 54.8%.

The sample from the Dana Bank is quite different from the samples of the northern banks in age and size composition. The 1956 year-class predominates with 43.2% while the 1957 year-class only amounts to 4.9%. The length frequency graphs in Figure 5 show clearly that the number of large cod increases gradually in the samples from north to south. In the samples from Store Hellefiske Bank the largest number of cod are by far too small in size to be of any value for the fishing industry.

Sample No. 11 is from the Nanortalik and Cape Farewell regions. In this sample the 1956 year-class predominated with 67.4%.

Inshore waters and fjords (Fig. 6)

20 samples were taken from coastal areas as follows:—

Division	A	B	C	D	F
Nos.	12 14	15–18	19–20	21–28	29–31

All samples from Divisions C and D, and sample No. 16 from B, are from catches taken by "Adolf Jensen". All other samples are from catches landed by Greenland fishermen.

A. Sample No. 12 is from a long-line catch in deep water and consists of old year-classes, the

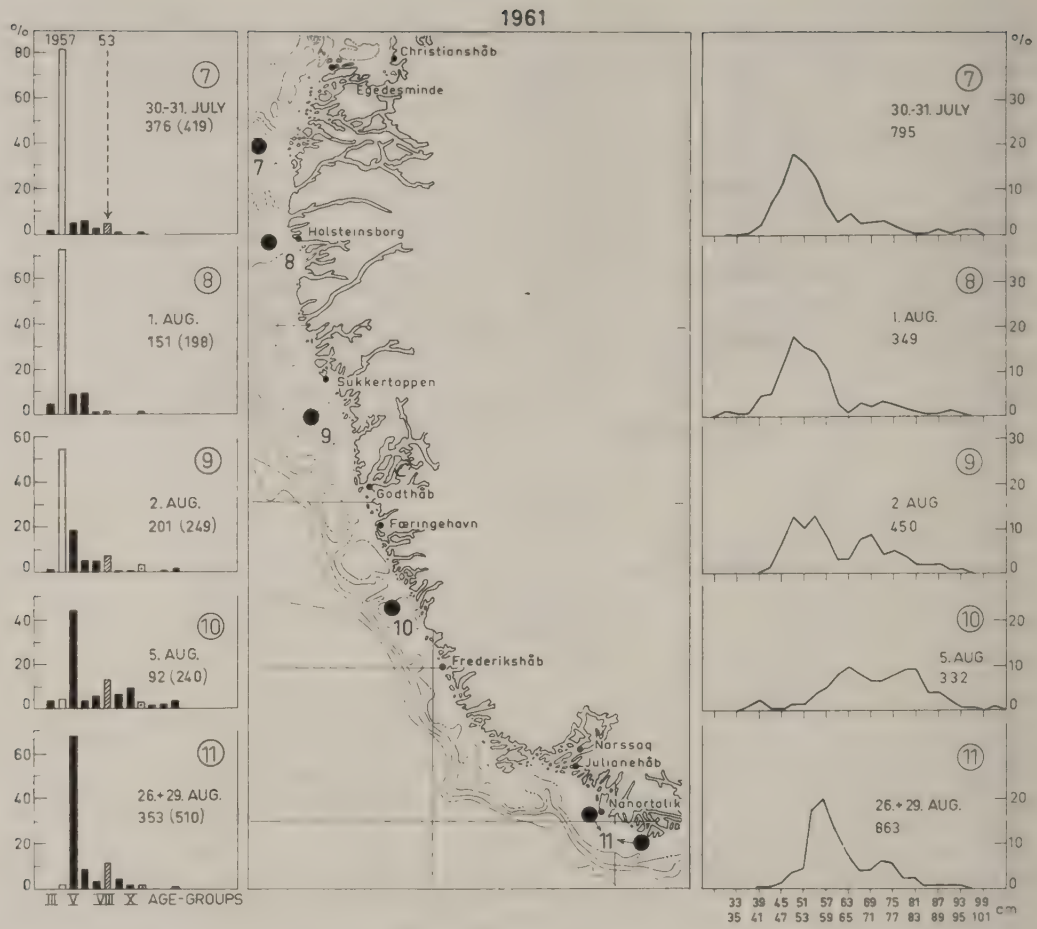

Figure 5. Percentage age and length distribution of cod from West Greenland banks. In the samples Nos. 7 to 10 the otoliths have been taken from cod not fit for tagging due to wounds from the jig. The age and length frequencies have, however, been converted to the total sample. Numbers of otoliths and cod tagged (in parentheses) are also shown.

1947 year-class being the most important (26.9%). The 1953, 1950, and 1954 year-classes provide 16.4%, 14.9%, and 10.4% respectively. In Nos. 13 and 14 the 1957 brood predominates with 63.1% and 28.0% respectively.

B. The 1953 year-class predominates in Nos. 15 and 17. In No. 17 it is followed very closely by the 1947 year-class. Sample No. 16 is from a catch taken by shrimp trawl in which the predominant year-class is 1953 with 27%, followed closely by 1955 (24.7%) and 1956 (21.3%). In sample No. 18 the 1957 year-class provides 58%.

C. Samples Nos. 19 and 20 from this division are caught in the same place and at the same time. No. 20 is a long-line catch and No. 19 is taken by hand-line. The predominant year-class in No. 20 is 1947 providing 20%, and the year-classes 1953, 1956, and 1957 are represented with 16.3%, 13.8%, and 12.5% respectively. No. 19 contains only small young cod, the 1957 year-class strongly predominant providing 65.5%.

D. As mentioned above, all 8 samples are from catches taken by "Adolf Jensen". Nos. 21, 22, 26, and 29 are caught with long-line,

Figure 6. Age distribution of cod caught in inshore waters and fjords in 1961.

while Nos. 23, 24, 25, and 27 are from catches with hand-line. In No. 21 the 1953 and 1957 year-classes are of equal strength. In the long-line samples Nos. 22 and 26 the 1953 year-class predominates, while in No. 28 the 1957 class is predominant with 53.1%. With the exception of No. 25 in which 1956 is the strongest year-class (62.1%), the hand-line samples have 1957 as the predominant year-class, with 1956 as second.

F. The three samples (29—31) from this division are characterized by the very strong predominance of the 1956 year-class providing 80, 87.4, and 75% respectively.

The old 1947 and 1953 year-classes are still of importance in the long-line catches from deep water. Of the younger year-classes the broods of 1957 and 1956 are by far the richest; the former chiefly occurs in the northern area, viz., Divisions A, B, and C. In D the 1957 brood is also the strongest but followed rather closely by that of 1956. In F, 1956 is the richest year-class among the young cod, while 1957 is poorly represented. This difference in the occurrence of these two year-classes is in conformity with the distribution of young cod found in 1959.

P. M. Hansen

German Investigations in 1961

(Tables 7–9)

German trawlers have fished off Greenland for the last 10 years. This fishery, like that of other nations fishing around Greenland, started as a seasonal fishery only, confined to the spring and summer months. In spite of very difficult weather conditions, this fishery has since 1958 expanded to comprise the whole year, and for the last two years it has been so intensive that Greenland since 1961 is the most important fishing area for the German trawlers. The development of the fishery is shown in Table 7. The figures for the fishery off Greenland in 1961 show a landing of 159,000 tons (gutted) fish, of which cod account for 51.2% and redfish for 40.4%. The rapid increase in the yields was chiefly caused by a more intensive fishery off South and West Greenland. Off West Greenland alone the cod landings increased from 1960 to 1961 to 61,500 tons, or three times the 1960 landings — also on account of a greater production of salt cod.

Investigations at sea could only be carried out during a cruise with the "Anton Dohrn", mainly intended for mesh size studies off East Greenland, and during a cod tagging cruise with a commercial trawler. All other data are from landings of trawlers, including samples of ungutted cod preserved especially for research.

West Greenland

Fishing was carried out off West Greenland throughout the year, except for the period 16. January to 24. February. Exceptionally low air temperatures (26°C below zero) obstructed considerably the fishery during March. In that month, German trawlers succeeded for the first time in locating large concentrations of spawning cod far westwards of the Banana Bank in surprisingly deep water, 350 to 550 m. Spawning was at its peak by the end of March and the beginning of April when 48% of the mature fish were spawning; 34% were just about to spawn, 14% had finished spawning, and 4% were close to finishing. About 10% of the cod in the spawning concentrations were young, immature fish. The 1953 year-class was predominant with 48% (see Table 8), and the 1955 and 1954 year-classes accounted for 17% and 11% respectively. The 1950 and 1947 year-classes, which were previously so strong, only provided 8% together. The proportions of immature cod in the year-classes were as follows:—

Year-class	%
1957	100
1956	100
1955	16
1953	5
1952	14

Table 7. Yields of 10 years' German fishery off Greenland (in tons)

Year	West Greenland						South Greenland					
	Cod (tons)	Redfish (tons)	Cod (%)	Red-fish (%)	Other fish (%)	Total (tons)	Cod (tons)	Redfish (tons)	Cod (%)	Red-fish (%)	Other fish (%)	Total (tons)
1952	822	300	71.8	26.2	2.0	1,145	1,250	—	95.4	—	4.6	1,310
1953	668	1	90.4	0.1	9.5	739	1,337	151	85.4	9.6	5.0	1,565
1954	829	106	86.0	11.0	3.0	964	153	10	88.4	5.8	5.8	173
1955	5,753	13,959	28.5	69.2	2.3	20,170	287	202	56.6	39.8	3.6	507
1956	23,669	6,065	76.9	19.7	3.4	30,780	566	574	46.5	47.2	6.3	1,216
1957	7,816	14,605	34.2	63.9	1.9	22,863	964	268	73.9	20.5	5.6	1,305
1958	18,241	9,252	63.9	32.4	3.7	28,549	6,684	1,732	75.4	19.5	5.1	8,863
1959	11,142	16,042	38.3	55.2	6.5	29,061	2,252	1,558	56.4	39.0	4.6	3,995
1960	18,664	14,894	50.9	40.6	8.5	36,662	522	5,395	8.3	85.5	6.2	6,310
1961	61,514	27,964	62.3	28.3	9.4	98,805	8,642	11,995	39.1	54.3	6.6	22,095

Year	East Greenland						Greenland Total					
	Cod (tons)	Redfish (tons)	Cod (%)	Red-fish (%)	Other fish (%)	Total (tons)	Cod (tons)	Redfish (tons)	Cod (%)	Red-fish (%)	Other fish (%)	Total (tons)
1952	—	—	—	—	—	—	2,072	300	84.4	12.2	3.4	2,455
1953	—	—	—	—	—	—	2,005	152	87.0	6.6	6.4	2,304
1954	—	—	—	—	—	—	982	116	86.4	10.2	3.4	1,137
1955	3,001	40,948	6.5	88.9	4.6	46,067	9,040	55,109	13.5	82.6	3.9	66,744
1956	7,437	33,094	16.6	74.1	9.3	44,683	31,672	39,733	41.3	51.8	6.9	76,681
1957	5,838	13,038	26.8	62.5	10.7	21,804	14,619	28,513	31.8	62.0	6.2	45,971
1958	4,553	8,883	31.3	61.1	7.6	14,538	29,478	19,866	56.7	38.2	5.1	51,952
1959	9,691	19,186	31.4	62.2	6.4	30,869	23,082	36,785	36.1	57.5	6.4	63,927
1960	15,378	30,250	31.1	61.2	7.7	49,421	34,560	50,538	37.4	54.7	7.9	92,389
1961	11,232	24,292	29.6	64.0	6.4	37,968	81,388	64,249	51.2	40.4	8.4	158,871

Table 8. Length and age compositions of cod from commercial samples taken at West and South Greenland 1961 (‰)

	West Greenland					South Greenland			
	Fylla and Banana Bank	West of Banana Bank	Noname Bank	Fylla and Fiskenæs Bank	Store Hellefiske Bank	Thor-valdsen	Deso-lation	Nanor-talik	Thor-valdsen
Length, cm	Jan.–March	April	May–June	Aug.–Nov.	December	Jan.–March	Apr.–May	May-July	Nov.
40– 44	—	—	—	1	—	—	—	—	—
45– 49	3	2	—	9	13	—	3	24	—
50– 54	33	3	17	41	181	6	27	230	43
55– 59	62	9	37	94	346	15	48	308	330
60– 64	130	80	37	156	193	22	67	131	336
65 –69	134	216	79	208	58	85	133	60	146
70– 74	180	316	215	153	65	181	214	102	41
75– 79	194	207	256	109	69	251	240	85	38
80– 84	135	96	199	97	44	238	173	41	43
85– 89	80	39	92	72	21	129	70	14	17
90– 94	32	25	54	42	8	51	18	3	5
95 –99	11	5	14	12	2	13	5	1	1
100–104	3	1	—	4	—	5	2	1	—
105–109	2	1	—	2	—	2	—	—	—
110–114	1	—	—	—		2	—	—	—
115–119	—	—	—	—	—	—	—	—	—
Average length	73.5	73.6	76.9	71.3	62.5	78.7	74.4	62.2	63.6
Year-class									
1958	—	—	—	4	—	—	—		—
1957	23	6	—	92	699	—	1	2	—
1956	150	34	84	496	76	31	82	2	762
1955	99	171	64	64	51	35	123	134	103
1954	109	117	216	45	34	66	126	35	17
1953	413	478	306	160	96	396	455	168	82
1952	50	51	36	33	6	64	51	41	15
1951	19	25	42	23	6	63	11	21	5
1950	41	48	121	33	10	169	84	42	11
1949	3	5	9	7	1	11	5	3	—
1948	9	4	29	6	3	29	14	2	—
1947	61	35	75	28	15	103	29	19	4
1946	2	8	—	3	—	7	2	—	—
1945	6	1	18	5	3	10	16	2	—
before 1945...	15	17	—	1		16	1	1	1

The landings from the trawlers in the period January to mid-March from the Fylla and Banana Banks showed a similar age composition, with the only difference that here — in more shallow water — the still immature 1956 year-class was second in strength with 15% (see Table 8). The mean lengths were approximately the same, 73.1 cm in January/March and 73.6 cm in March/April.

Cod is generally caught in shallower water than redfish. Off West Greenland, however, observations from 1961 show that in the spawning season cod can be concentrated at greater depths than redfish. Similar observations of a reverse depth distribution of cod and redfish were made during the cod spawning season off south-east Greenland. It was already noted in 1960 that 550 m was by no means the greatest depth for spawning cod. The concentrations at this depth had not decreased in strength, but the bottom conditions had not permitted fishery below this depth. The overall hydrographic conditions off West Greenland indicate that spawning cod must migrate into greater depths due to the deep level of the warm Atlantic component of the West Greenland Current. It is therefore necessary that further spawning places farther westwards, south of 64°N, must be sought for. These most recent observations show that the transport of Greenland cod larvae by means of the left branch (towards Baffin Land and Labrador) of the West Greenland Current must be considerably greater than previously assumed. It is possible that the varying strength of the year-classes, i.e. the number of young cod left in Greenland waters, is directly dependent on the depth range and volume of the Atlantic component of the West Greenland Current. The correlation between water temperature and year-class strength, observed by RASMUSSEN, may therefore well be related to the depth range and

the more eastern or western displacement of the warm Atlantic water. The solution of this problem could be a promising part of the international hydrographic researches planned for next year.

As in previous years, the older year-classes were found in the area of the southern West Greenland banks, especially on Noname Bank. Here, at the beginning of June — the best fishing season — the old and strong 1950 and 1947 year-classes accounted together for 20%; in 1960 even for 38%. Due to the high mean lengths (1950 year-class, 84.1 cm; 1947 year-class, 85.0 cm) of these 11—14 year-old cod the exceptionally high average length for Greenland cod of 76.9 cm was observed (in 1960 75.3 cm). The 1953 and 1954 year-classes predominated on Noname Bank with 31% and 22% respectively (see Table 8).

The autumn and early winter catches presented a completely different composition of the stocks. The 1956 year-class (with a mean length of 66.1 cm) was predominant (50%) in the landings from Fylla and Fiskenæs Banks from mid-August to the beginning of November, whereas the successful December fishery on the southern part of Store Hellefiske Bank depended on the exceedingly strong 1957 year-class which accounted for 70%. At the end of the fifth growth season the newly recruited 1957 year-class had an average length of 57.5 cm.

The future fishery off West and South Greenland will depend upon these two very strong year-classes. Both present a typical distribution. The 1957 year-class presents (like the once so rich 1947 year-class) a northern distribution, whereas the 1956 year-class (as the famous 1945 year-class) is mainly distributed in the southern part of West Greenland, chiefly in South Greenland. The importance to the fishery of the 1956 year-class was already predicted in 1958 as a result of the German search cruises. From the distribution pattern, which is now established, it can be concluded that this year-class to a considerable extent is derived from East Greenland (possibly also in part from Iceland), whereas the rich 1957 year-class is derived from the West Greenland stock. The exhaustive fishery on the rich, older 1950 and 1947 year-classes, resulting in a rejuvenescence of the stock, is now for West Greenland causing the end of a period with catches of relatively large fish, and in future we may expect lower mean lengths of the fish. Besides the 1956 and 1957 year-classes, the 1953 year-class will be the only important one in 1962/63.

South Greenland

The ice conditions were more favourable in 1961 than in 1960, making it possible to fish for cod and redfish off South Greenland through almost the whole of the winter. The unusually high mean length of 78.7 cm for cod caught there from the end of January to mid-March is noteworthy. The older 1953, 1950, and 1947 year-classes were predominant with 40%, 17%, and 10% respectively. Observations on maturity revealed that this stock was almost exclusively composed of mature individuals in the pre-spawning stage (V). Previous observations, tagging results, and the observed uniform age and length compositions of the catches from March to April proved that these large cod were migrating towards the spawning places off East Greenland, where the spawning reaches its maximum in April. That the cod during its spawning migration towards the east pass South Greenland in late winter becomes also evident from the fact that the cod fishery there remains idle from mid-March to the end of April. It starts anew at the end of April or the beginning of May, and then again with catches of large cod with an age composition similar to that found in late winter (see Table 8).

The fishery for the large re-migrating post-spawners changes soon to a fishery for young, immature fish. The catches from mid-May to the beginning of July were predominated by the rich 1956 year-class (53%, mean length 55.8 cm) which is especially abundant in the south. By November this year-class had reached a length of 60.2 cm and now providing 76% of the catches. The slower growth of the cod in the colder waters of South Greenland is clearly demonstrated by the fact that on Fylla Bank the 1956 cod at the same time had reached a length of 67.8 cm. Of the 1957 year-class, which prevails on the northern banks, only few specimens were observed off South Greenland.

East Greenland

(*a*) *South-east Greenland* (*Discord Bank to MØsting Ground*)

The winter fishery for cod and redfish on the difficult fishing grounds of south-east Greenland was again much obstructed by heavy ice and strong gales, but the few favourable days brought successful fishing. An intensive spawning activity was observed, especially on Fylkir and Bille Banks. The spawners were also here observed at great depth, about 400 m. In the period beginning of March/beginning of April the spawning shoals had almost the same length and age compositions as the landings from South Greenland in January/March (Table 8). The three most important year-classes, 1953, 1950, and 1947 were represented in the catches by 30%, 17%, and 13.5% respectively (Table 9).

Table 9. Length and age compositions of cod at East Greenland 1961 (‰)

	South-East Greenland	Angmagssalik		Dohrn Bank				
	Commercial samples	Research samples		Commercial samples/Research samples				
Length, cm	March–April	July	November	January	April	May	July–Oct.	December
40– 44	—	—	—	—	2	10	—	3
45– 49	—	—	—	—	4	22	1	30
50– 54	—	—	—	3	9	41	5	24
55– 59	3	5	16	11	15	85	13	27
60– 64	15	5	38	14	28	80	19	48
65– 69	73	20	47	39	80	95	25	75
70– 74	185	89	38	153	164	149	91	63
75– 79	278	162	87	192	212	174	144	108
80– 84	223	281	140	213	215	170	206	178
85– 89	131	286	212	196	172	109	193	168
90– 94	62	103	244	116	54	39	148	183
95– 99	20	34	124	34	29	19	94	72
100–104	5	15	42	28	16	7	34	15
105–109	2	—	12	1	—	—	20	6
110–114	2	—	—	—	—	—	6	—
115–119	1	—	—	—	—	—	1	—
Average length	79.6	83.5	86.3	82.0	79.3	74.0	84.9	80.9
Year-class								
1958	—	—	5	—	—	23	10	61
1957	—	5	39	4	15	65	37	59
1956	—	34	126	31	79	209	94	147
1955	24	48	107	41	51	84	71	77
1954	56	35	130	82	29	103	55	31
1953	298	434	309	269	350	248	276	260
1952	98	170	67	96	163	38	104	76
1951	88	54	27	74	91	21	45	82
1950	167	189	138	319	149	144	200	171
1949	23	—	36	62	63	39	66	36
1948	44	—	—	14	6	14	7	—
1947	134	26	16	1	4	3	19	—
1946	17	5	—	—	—	—	—	—
1945	33	—	—	7	—	—	13	—
before 1945	18	—	—	—	—	9	3	—

(*b*) *East Greenland* (*Heimland Ridge to Dohrn Bank*)

Only a few cod were landed from the redfish fishing ground off Angmagssalik. A by-catch of cod investigated on board "Anton Dohrn" at the end of July showed also a predominance of the 1953 year-class (43%), followed by the 1950 year-class (19%), and the 1952 year-class (17%). The maturity investigations re-confirmed the earlier observations of the relatively late maturing of the East Greenland cod. In spite of a mean age of almost 9 years with a length of 83.5 cm, 58% of the cod were still immature. The proportions of immature cod in the year-classes were as follows:—

Year-class	%
1953	60
1952	76
1951	46
1950	22

When fishing started on the Dohrn Bank in 1955 only redfish were caught but now the bank has gradually changed into a cod fishing ground and the fishery is carried on throughout the year. The bank presents the most favourable fishing conditions in the winter and spring when the East Greenland cod concentrate there for spawning purposes or pass on their migration to Iceland. For two years this former redfish ground has even sustained a salt-cod fishery from March to May.

In all the samples from the Dohrn Bank, from January to December, the rich, old 1953 and 1950 year-classes predominated with 35% and 32% respectively. Thus the cod fished on the Dohrn Bank in 1961 were relatively large, similar to the preceding years, that is, the Dohrn Bank is actually not a nursery ground for immature cod. Among the few young cod, the 1956 year-class is prevailing with up to 21% (see Table 9).

This predominance of the 1956 year-class may also confirm the above conclusion that the rich stock of 1956 cod off South and south-west Greenland originate from East Greenland or from Iceland.

It is to be noted that the 1947 cod which in 1961 still were of considerable commercial importance off South and East Greenland, were almost completely absent in the Angmagssalik and Dohrn Bank areas. The 1947 cod are obviously — judging from the structure of the otoliths and the slower growth-rate — West Greenland cod. They originally grew up under conditions of over-population and undernourishment on the northern banks off West Greenland, then they spread towards the south, appeared since 1954/55 in great numbers off South Greenland and, finally, in 1956 and 1957, they constituted a considerable part of the catches at Angmagssalik and on Dohrn Bank. Since 1958 cod of the 1947 year-class are, however, poorly represented in the catches from Angmagssalik and the Dohrn Bank.

Tagging experiments

From October 1959 to October 1960, 1,728 cod were tagged off SW, S and SE Greenland with yellow DHb plastic tags with yellow or blue/white/red flaps or with plastic tag only. Until May 1962, 69 recoveries were reported, the total recoveries being 4%. All the cod recorded had migrated as expected. Large, mature or maturing fish travelled during the winter on their spawning migrations against the current, and were recaught off SE and East Greenland and off Iceland. After having spawned the cod migrated with the current from SE and South Greenland to West Greenland, northward as far as Disko Bay. Smaller, immature fish were for the most part recovered near the tagging locality or had migrated on their summer migration to the coastal area and in one case right into the innermost part of a fjord (Fylla Bank to Godthåb Fjord). The maximum speed against the current was 7.5 miles per day, with a current velocity of 17 miles per day. Off Iceland 12 cod were recovered (1 report uncertain), off the NW coast 10 fish, and off east Iceland 1. This latter cod had migrated at least 1,100 miles (from Nanortalik Bank (South Greenland) to Glettinganes). Tagged on the 1. May 1960 this cod obviously began its spawning migration in the winter of 1960/61 to north-west Iceland (1 spawning ring on the otoliths), and after having spawned it continued to east Iceland for feeding. When recaptured after $18^1/_2$ months in the sea this 9 year-old cod was 94 cm long and had grown 17 cm. The maximum growth found, however, was 25 cm and 27 cm within two years and five months.

ARNO MEYER

Norwegian Investigations in Greenland Waters in 1961

(Figures 7–14)

West Greenland

The fishing experiments were carried out off the coast of West Greenland in the period 12. April to 11. May. Comparatively good catches were obtained in the whole area investigated, that is, between Nanortalik Bank and the Holsteinsborg Deep. Only at one station situated in the Holsteinsborg Deep, the catch was really poor. The cod had largely completed spawning but were nevertheless in very good condition. The distribution on the banks was nearly the same as in 1960. In some places, however, the mature cod were found in still shallower water than previously at the same time. This was probably caused partly by the favourable temperature conditions in the upper water layers and partly by migration to the feeding grounds after spawning. Immature cod were this year also encountered on the top of some banks where the temperature was relatively low.

The length of the fish varied much from bank to bank. The largest fish were caught in Julianehåb Bay, on Noname Bank, Frederikshåb Bank, Dana Bank, and on Lille Hellefiske Bank where the mean length of the cod at the northernmost station was 80.74 cm. The smallest cod were taken on Fylla Bank where the mean length was 73.8 cm. In one long-line catch the mean length was only 55.41 cm. Regardless of gear, these were also the smallest fish taken.

Figures 7 and 8 show the length and age composition of the total catch of cod taken on bottom long-lines. The mean length is 76.27 cm. At the same time last year the mean length was only 73.27 cm. The increase in the overall mean length must largely be due to the growth of the 1953 year-class, which constitutes 37.21% of the total long-line catch and has a mean length of more than 77 cm. On the other hand, the percentage of fish more than 9 years old has increased since last year, and these fishes contribute of course also greatly to the increase in mean length. This increased mean length might suggest a deficient recruitment of young fish to the long-line fishery, but such an interpretation is probably incorrect. The long-line catches do not represent the whole

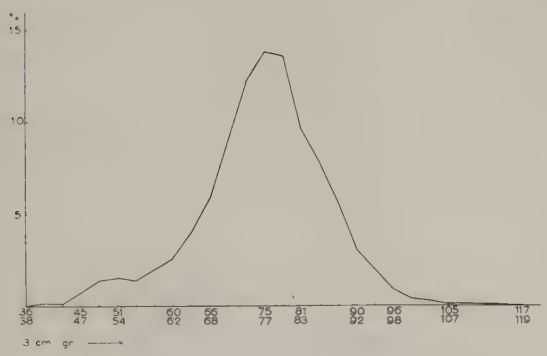

Figure 7. "Johan Hjort", West Greenland, April/May 1961. Length composition of the cod. Total bottom long-line catches.

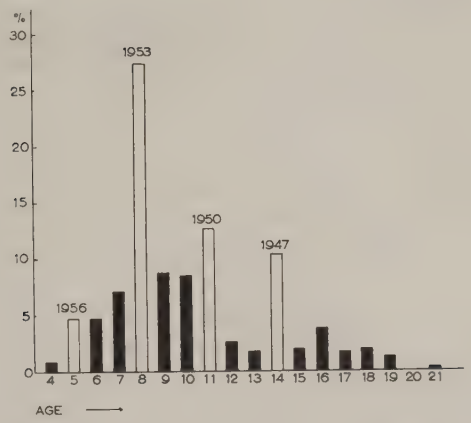

Figure 8. "Johan Hjort", West Greenland, April/May 1961. Age composition of the cod. Total bottom long-line catches.

cod population as only the mature part of the stock is fished.

In Figures 9 and 10 the length and age compositions are shown of the cod in the total trawl catch. Compared with the bottom long-line catch the trawl catch is dominated by small fish. The cod in the trawl catches are largely immature, but the sampled material does not represent the whole West Greenland cod population. The material may, however, give a hint as to the recruitment to the long-line fishery.

Compared with the trawl catches in 1960 there is again a strong 4 year-old group, however not as dominant as last year. The loss of dominance of the 4 year-old fishes in 1961 is probably due to the strength of the 1956 year-class. As 4 year-olds last year, this year-class was promising, an aspect which now seems to be confirmed. In other words, the 1956 year-class will probably be strong and give good recruitment to the long-line fishery in the next years.

In 1962 the 1947 and 1950 year-classes will probably be of very little importance to the West Greenland long-line fishery. The 1953 year-class will be predominant, but its importance seems to be of a decreasing character. The mean length of cod caught on long-lines may remain much the same as in 1961, but this depends on the influence of the 1956 year-class. If the influence of this year-class is going to be strong, we may experience a slight decrease in the mean length of the cod taken on bottom long-lines.

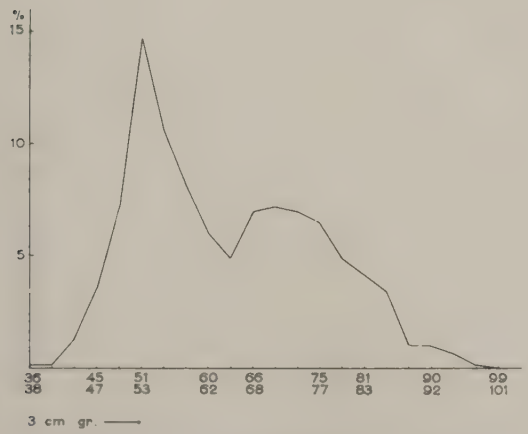

Figure 9. "Johan Hjort", West Greenland, April/May 1961. Length composition of the cod. Total trawl catches.

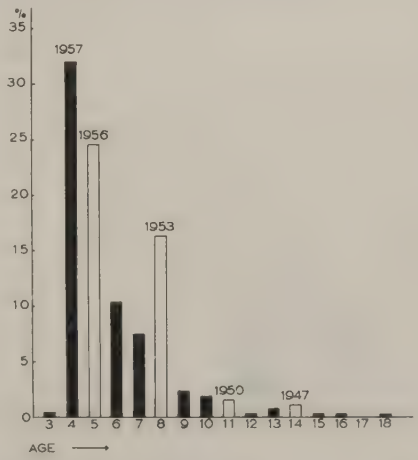

Figure 10. "Johan Hjort", West Greenland, April/May 1961. Age composition of the cod. Total trawl catches.

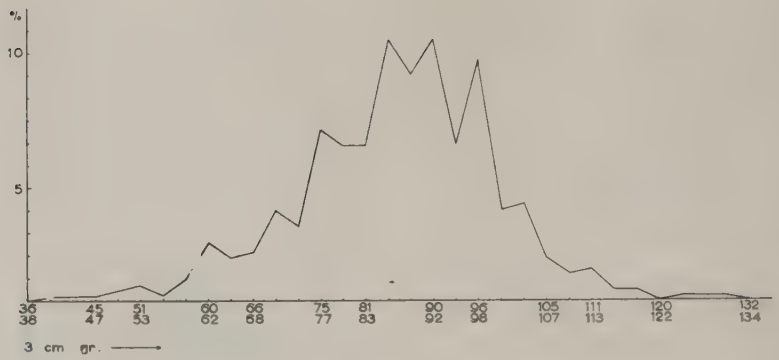

Figure 11. "Johan Hjort", East Greenland, August/September 1961. Length composition of the cod. Total bottom long-line catches.

East Greenland

In August/September 1961, the R.V. "Johan Hjort" visited the East Greenland waters between Cape Farewell and Cape Dan. This year no localities were found where cod were completely absent, but compared with the year 1959 the catches on bottom long-lines off the coast were rather poor. Only off Cape Dan, about 5 miles offshore, the fishing was really good. In Skjoldungen very good catches were obtained by hand-line.

Figures 11—14 show the length and age composition of the total yield of cod taken on bottom long-lines and on hand-lines. The mean length of the long-line catches is 85.9 cm, almost the same as in 1959 (86.1 cm). Off Cape Dan the largest cod were found. Here the mean length was 93.4 cm. The cod caught on hand-line had a lower mean length. In the South- and Northfjord in Skjoldungen the mean length was 74.2 and 80.3 cm respectively. All the cod were in very good condition.

The 1953 year-class is predominant and the 1950 year-class has comparatively the same strength in both the long-line and the hand-line catches. On the other hand, a slight difference in the age composition is noted. The 1947 year-class is of considerable importance in the long-line catches, thus influencing the mean length values. This year-class is much weaker in the hand-line catches. Here the 1956 year-class is comparatively strong and seems to be promising for the recruitment to the long-line fishery in the next years.

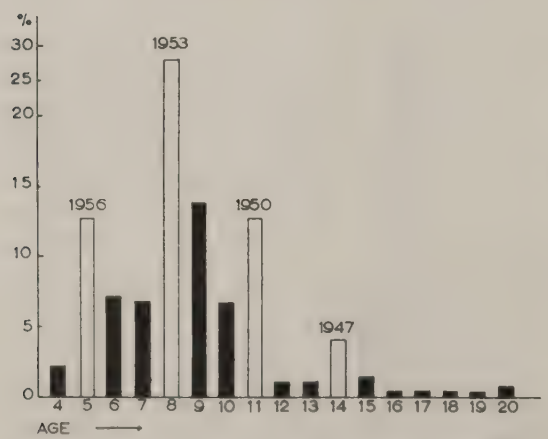

Figure 12. „Johan Hjort", East Greenland, August/September 1961. Age composition of the cod. Total bottom long-line catches.

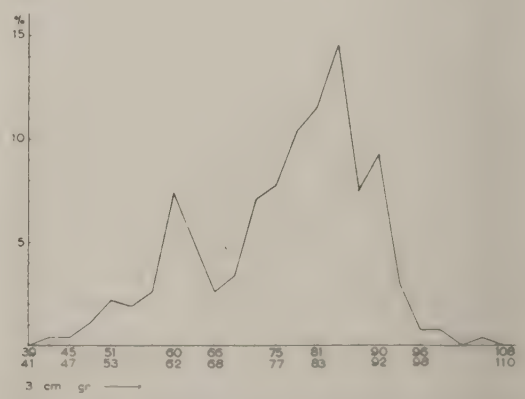

Figure 13. "Johan Hjort", East Greenland, August/September 1961. Length composition of the cod. Total hand-line catches.

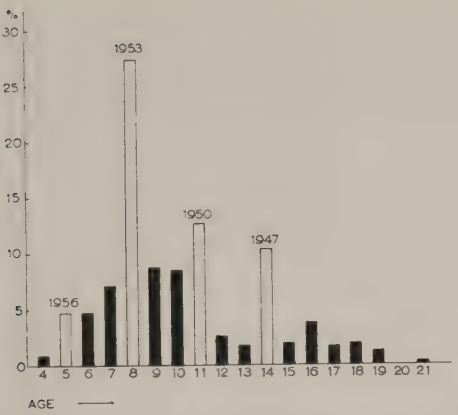

Figure 14. "Johan Hjort", East Greenland, August/September 1961. Age composition of the cod. Total hand-line catches.

From the investigations in East Greenland waters in 1959 and 1961 it seems safe to conclude that a combined bottom long-line and hand-line fishery might be profitable. In the beginning of the season, from mid-June to mid-August, the cod was to some extent found in pelagic shoals on the banks off the entire coastal stretch from Cape Farewell to Angmagssalik. Later in the season the fish moved into some of the fjords to feed on capelin and fry of capelin. In Angmagssalik Fjord and the North- and Southfjord in Skjoldungen the conditions are of such a character that the cod almost unfailingly migrate into these fjords.

ERLING BRATBERG

Iceland Stock

The Spawning Stock of Cod in 1961

(Table 10)

Table 10 shows the age distribution of the spawning stock of cod in 1961. It is based upon material collected from long-line and gill-net catches taken on the spawning grounds off the south and south-west coasts of Iceland during the period January to May.

The 1945, 1949, 1950, and in part also the 1955 year-classes have been predominant in the spawning stock of cod. The numbers present on the spawning grounds of the 1955 year-class in 1960 and 1961 were quite surprising, although a good deal of this year-class was still immature.

The 1955 year-class was also quite abundant in the Icelandic trawler catches and presumably also in the catches taken by other nations fishing in this area. As far as can be judged at present, the fisheries for the next 2—3 years seem to become dependent on this year-class.

JÓN JÓNSSON

Table 10. Icelandic spawning stock of cod, 1961

	Age at first spawning										
Age-groups	4	5	6	7	8	9	10	11	12	13	Total
IV	49	—	—	—	—	—	—	—	—	—	49
V	2	332	—	—	—	—	—	—	—	—	334
VI	—	18	1911	—	—	—	—	—	—	—	1,929
VII	—	2	110	1487	—	—	—	—	—	—	1,599
VIII	—	—	29	296	1496	—	—	—	—	—	1,821
IX	—	4	2	57	292	738	—	—	—	—	1,093
X	—	—	—	5	52	282	585	—	—	—	924
XI	—	4	—	27	45	178	724	902	—	—	1,880
XII	—	—	—	4	15	15	52	151	59	—	296
XIII	—	—	—	—	9	—	—	9	4	—	22
XIV	—	—	—	—	—	4	16	—	—	—	20
XV	—	—	—	—	—	5	4	9	4	4	26
XVI	—	—	—	—	—	—	—	2	—	—	2
XVII	—	—	—	—	—	—	—	—	—	—	—
XVIII	—	—	—	—	—	—	—	—	—	—	—
XIX	—	—	—	—	—	—	—	—	4	—	4
Total	51	360	2,052	1,876	1,909	1,222	1,381	1,073	71	4	9,999

	Spawning classes								
	1	2	3	4	5	6	7	8	Total
Number	7,559	1,879	383	71	71	23	9	4	9,999

German Investigations in 1961

(Tables 11–12)

In 1961 the fishing grounds off Iceland lost their permanent predominance for the German far distant trawl fishery. The total catch off Iceland decreased further by 24%, while the number of trips was only reduced by 19%. Thus the average daily catch dropped to 11.6 tons, the lowest yield per fishing day since 1950. Mainly the catch of cod decreased, from 30,596 tons in 1960 to 17,561 tons in 1961. Most of the cod (79%) were caught off NW Iceland, as in the previous years.

In contrast to earlier years, the spring cod fishery off SW Iceland is today of very small importance for the German market. The catches of cod taken there are only a by-catch of the redfish fishery. The 11 and 8 year-old cod were most significant in these catches, providing 28% and 27% respectively. The numbers of the strong 1950 year-class (average length in 1961, 89 cm) dropped considerably.

From May to June the fishery off the NW coast is based on cod. In contrast to preceding years the immigration of cod from East Greenland seems to have been slight. In 1961 the average lengths of the predominant year-classes, both off the NW and the SW coast, were namely almost the same; they were evidently not reduced off the NW coast as in other years due to a strong immigration of slower growing East Greenland fish. A further evidence of less immigration into NW Icelandic waters of these cod may be deduced from the fact that the average daily yield in May dropped from 12.6 tons in 1960 to 6.7 tons in 1961.

Table 11. Length and age compositions of cod taken by German trawlers SW and NW of Iceland in 1961 (‰)

Length, cm	SW March–April	NW May–June	NW August–Dec.
40–44	—	1	7
45–49	—	4	30
50–54	1	14	49
55–59	5	39	63
60–64	3	63	93
65–69	12	93	126
70–74	50	137	118
75–79	156	146	136
80–84	269	193	134
85–89	262	132	102
90–94	180	99	82
95–99	38	41	36
100–104	18	18	18
105–109	4	11	5
110–114	2	3	1
115–119	—	2	—
120–124	—	2	—
125–129	—	2	—
Average length	85.0	79.4	74.9
Year-class			
1958	—	3	112
1957	4	67	215
1956	30	178	241
1955	52	152	108
1954	79	70	41
1953	266	234	97
1952	72	71	45
1951	146	42	36
1950	278	143	77
1949	63	35	25
1948	—	2	3
1947	7	2	—
1946	—	—	—
1945	3	1	—

Table 12. Further recaptures of German taggings off SW, S and SE Greenland

Date and location of Tagging: Date	Location	Length, cm	Recaptures: Date	Location	Length, cm
13. Dec. 1959	Noname Bank 62°02′N; 50°38′W	65	17. May 1961	NW Iceland, Gammelloch 66°40′N; 24°40′W	?
18. Dec. 1959	Sermersut 61°19′N; 49°49′W	55	4. Dec. 1961	NW Iceland, off Cape North	71
18. Dec. 1959	Sermersut 61°19′N; 49°49′W	66	15. May 1962	NW Iceland, Gammelloch	91
19. Dec. 1959	Dana Bank 62°37′N; 51°28′W	55	17. May 1962	NW Iceland, Gammelloch	82
1. May 1960	Nanortalik Bank 59°59′N; 46°25′W	77	21. Nov. 1961	E Iceland, Glettinganes, 65°30′N; 12°W	94
28. Sept. 1960	Nunat 59°41′N; 44°07′W	79	31. Mar. 1961	NW Iceland, off Vatneyri	75?
28. Sept. 1960	Nunat 50°41′N; 44°07′W	77	4. July 1961	NW Iceland, Gammelloch	?

In the samples taken from the beginning of May to the beginning of June the 1953 year-class was predominant with 23%, followed by the 1956 (18%) and 1950 (14%) year-classes. In the catches taken off NW Iceland in autumn and early winter the younger year-classes prevailed, providing 24% (1956), 22% (1957), 11% (1958), and 11% (1955). It is interesting to note that among the younger year-classes the 1956 brood is well represented both off Iceland and off East and South Greenland (see p. 116).

From the tagging experiments carried out off south-west, South and East Greenland in 1959 and 1960, 7 further recaptures in Icelandic waters off the north-western and eastern coasts were reported (see Table 12). All 11 cod recovered off Iceland (16% of all the recaptures) were mature fish, larger than 70 cm and, for the most part, tagged in autumn and winter. The maximum growth observed was 27 cm within two feeding seasons. The greatest distance covered was 1,100 miles, from South Greenland to East Iceland.

ARNO MEYER

Arcto-Norwegian Stock

Results of Soviet Tagging Experiments in the Barents Sea

(Figures 15–16; Tables 13–15)

In 1961, 14,722 cod were tagged in the Barents Sea with Gilbert tags and 344 cod with green hydrostatic tubes. Recoveries of Gilbert tags amounted to 2.4% or 352 specimens, the hydrostatic tag recoveries constituted 15.7% or 56 specimens. In the Barents Sea a total of 1,599 cod have been tagged with hydrostatic tags, viz., 160 in 1959; 1,095 in 1960; and 344 in 1961. A total of 64 cod have been recaptured during that period, viz. one tag in 1959; 14 tags in 1960. In 1961 Murman fishermen furthermore recaptured 143 cod tagged with Norwegian (73) and

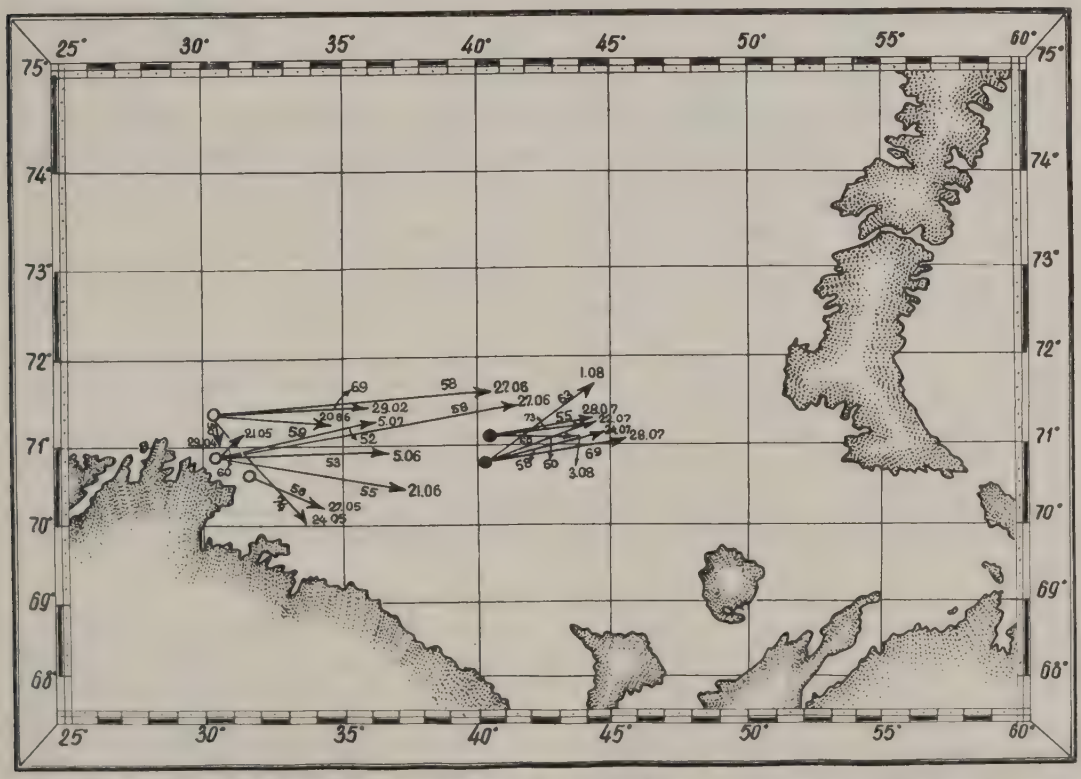

Figure 15. Eastward migrations of cod in the summer of 1961. The direction of movement and the places of recapture are shown by arrows. The data of recapture and the length of the fish are shown near the arrows. The arrows connect the places of release and recapture, but do not represent the real distance covered by the fish. ○ = release in April. ● = release in June.

Table 13. Migrations of cod on the Murman and Finnmark Banks and in the Norwegian Gully

Tagging				Recapture			
Date 1961	Locality N E	Length, cm	Tag No.	Date 1961	Locality N E	Number of days at liberty	Distance covered per day (limes)
22. Feb.	71°05′ 35°15′	58	49392	1. Mar.	70°55′ 36°12′	7	1.4
22. Feb.	71°05′ 35°15′	42	53077	18. Mar.	71°13′ 35°13′	24	0.7
22. Feb.	71°05′ 35°15′	47	53024	10. Apr.	71°12′ 35°42′	48	0.2
22. Feb.	71°05′ 35°15′	51	53014	2. May	71°08′ 31°36′	69	1.4
30. Mar.	71°05′ 35°45′	52	53808	7. Apr.	71°03′ 35°18′	8	1.2
30. Mar.	71°05′ 35°45′	67	53770	6. May	71°07′ 32°00′	37	2.0
30. Mar.	71°05′ 35°45′	39	53640	19. May	70°20′ 32°35′	50	1.6

English (70) tags. All the information on the recaptured fish tagged with foreign tags was sent to the countries whose ships carried out tagging experiments. Unfortunately, the scientific staff of the Polar Institute cannot in its practical work use the information on fish tagged with English and Norwegian tags. For the bulk of these fish the time and locality of tagging are unknown for a long time. Twenty-eight cod tagged by the Polar Institute were recaptured by English, French, and Norwegian fishermen. Information on these recaptures was received by the Institute.

In the southern part of the Barents Sea immature cod on their wintering migration from east to west reached the Murman and Finnmark Banks and the Norwegian Gully in January/February. Until the end of April/beginning of May they moved slowly in a western direction but remained in the above mentioned area (Table 13).

The number of cod approaching the Ribachya and Kildin Banks was rather low corresponding to the low capelin runs to these areas. In June the cod began their eastward migration from Finnmark Bank and the Norwegian Gully; they moved across the Murman Bank (Fig. 15). By the end of July/beginning of August they reached the slopes of the Goose Bank. Among these fish there were many specimens which were tagged in February/March on the spawning grounds by English and Norwegians investigators. In August/September the cod were spread over wide areas of shallow water off Novaya Zemlya where they fed intensively on polar cod. After feeding in the east the cod moved slowly westwards in November/December. In December the main concentrations of wintering fish were in the north central area and in the adjacent waters of the northern slope of the Murman Shallows.

The cod tagged in spring and summer near the Murman coast were caught in September in the Murman Shallows. In October all the fish left the inshore waters and entered the main stream of the Murman Current.

In the north-western areas immature cod moved within the limits of the slopes of Bear Island and West Spitsbergen, at first towards south and then northwards (Table 14).

The mature cod in the Bear Island/Spitsbergen area approached NW Norway in January/February. The cod bearing tag No. 492 was released on 19. November 1960 near West Spitsbergen and was recovered by Norwegian fishermen on 23. January 1961 at 66°00′N and 12°40′E. Spent fish appeared the first time in the Bear Island/Spitsbergen area in May (Fig. 16).

Table 15 shows examples of joint migrations of cod, according to the dates of recapture in 1961.

In 1961 a great many fish were caught which had been tagged in the same place and recaptured at the same time, or within intervals of 1—4 days.

Table 14. Migrations of cod in the Bear Island/Spitsbergen area

Tagged				Recovered			
Date 1960	Locality N E	Length, cm	Tag No.	Date	Locality N E	Number of days at liberty	Distance covered per day (miles)
19. Nov.	76°55′ 14°15′	52	14586	23. Jan.	75°20′ 15°30′	65	1.4
18. Nov.	76°45′ 13°45′	49	436	31. Jan.	75°38′ 14°50′	73	0.9
20. Nov.	76°55′ 14°15′	57	14696	18. Feb.	74°22′ 17°31′	90	1.8
19. Nov.	76°55′ 14°15′	61	14600	30. Apr.	72°45′ 15°45′	162	1.5
19. Nov.	76°55′ 14°15′	49	14627	16. May	74°03′ 16°47′	178	—
19. Nov.	76°55′ 14°15′	65	14697	9. June	74°00′ 21°30′	202	—
19. Nov.	76°45′ 13°45′	50	536	27. July	77°34′ 13°12′	244	—

Figure 16. Migrations of mature cod from the spawning grounds to the feeding area according to English and Norwegian tagging experiments and places of recapture of fish tagged by Murman fishermen (for details, see Fig. 15). ● = release in February; ○ = release in March; ⊙ = release in April.

Table 15. Joint cod migrations

Tagged				Recovered			
Place of tagging N E	Date of tagging	Length, cm	Tag No.	Place of recapture N E	Date of recapture	Number of days at liberty	Distance covered in straight line (miles)
71°05′ 42°20′	13. Sept. 60	64	7274	69°35′ 34°50′	23. May	252	180
71°05′ 42°20′	13. Sept. 60	85	7266	69°30′ 35°00′	27. May	256	180
71°05′ 35°45′	22. Feb. 61	49	49291	70°20′ 32°17′	20. May	87	70
71°05′ 35°45′	22. Feb. 61	44	49324	70°10′ 32°00′	23. May	90	70
70°55′ 31°15′	30. May 61	50	49637	71°18′ 34°36′	20. July	51	70
70°55′ 31°15′	30. May 61	53	49455	71°18′ 34°36′	20. July	51	70
70°45′ 40°15′	15. June 61	58	59460	71°07′ 44°42′	24. July	39	110
70°45′ 40°15′	15. June 61	66	59149	71°07′ 44°42′	24. July	39	110

We have selected specimens which had migrated together and spent a long time in the sea. The data presented in Table 15 show that shoals of cod apparently are unchanged for a long time. Fish tagged at the same time and which had joined any shoal move subsequently close to each other, and that is the reason why they are recovered together. Observation of this behaviour is very interesting. The cod bearing tag No. 7274 (a male) was at stage VI/II when recaptured. Sex and maturity stage of the accompanying fish No. 7266 are unknown. Both of these fish were obviously on the spawning ground and were recaptured during their summer migration eastwards. The real distance covered by the fish is apparently 3—4 times as long as that given in Table 15. This example shows that even on the spawning grounds the cod are able to keep to their shoals — anyhow to some extent. The examples of joint migrations of cod given in Table 15, testefy to a highly developed shoaling instinct in cod.

V. P. Ponomarenko

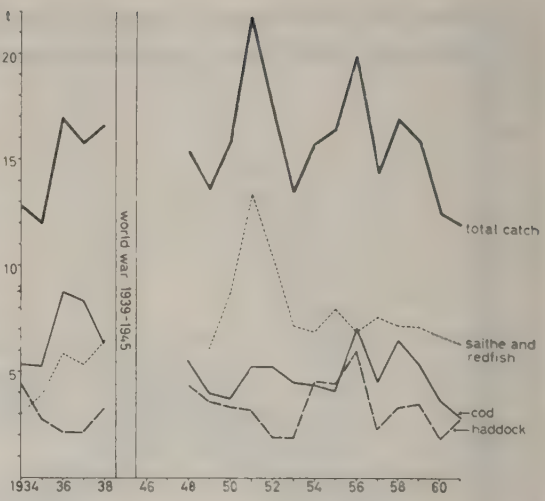

Figure 17. Average yield per day's fishing of German trawlers from January to April off the Norwegian coast (Svinøy omitted) during the years 1934 to 1961.

German Investigations, 1961

(Figure 17; Tables 16–17)

In the north-eastern area profitable fishing has become a great problem for all the nations exploiting the arctic stocks, especially the stock of cod. Table 16 shows the landings of the German trawlers since 1930, when the fishery off Bear Island was started, and since 1934 when trawling began off the north-western Norwegian coast. Before the war, up to 75% and, in 1957, even 57% of the total catch landed by German trawlers was caught in these regions. In 1960 these landings constituted only 8% and in 1961 they were as low as 5.5%! After 1958 German fishing in the Barents Sea and off Bear Island was nearly abandoned, as the level of no economic return was reached. Now the trawlers fish for large mature cod outside the Lofoten area during the winter/spring season only, but the landings of cod as well as of haddock, saithe and redfish are constantly decreasing (see Figure 17 and Table 16). As is shown in Figure 17, the average daily catch of cod during the period January to April 1961 dropped to 2.8 tons. This is the lowest yield since German trawling began off the north-western Norwegian coast.

In fact, how weak the stock of mature cod is today becomes evident when we compare not only the catch per day's fishing of pre-war times with that of today, but also when the increased fishing effort of present days' big trawlers is taken into consideration. According to Lundbeck (Mitt. Inst. Seefisch., Hft. 10, 1960), the fishing power of the trawlers operating today off the NW Norwegian coast is about four times that of the trawlers operating there before the war. In the years 1934 to 1938 the small trawlers caught between 5.0 and 8.7 tons per day's fishing. In 1961, the big, modern and well equipped trawlers caught 2.8 tons per day. This means that a trawler of pre-war type in 1961 would have caught 0.7 ton. On the assump-

Table 16. Landings of cod since the beginning of the German fishery in the Malangen/Röst area and percentage of the total landings of cod by German trawlers

	Tons	%
1934	6,865	11
1935	17,718	21
1936	36,280	31
1937	48,891	39
1938	32,974	26
1948	13,117	30
1949	9,397	17
1950	11,930	23
1951	14,168	26
1952	13,682	24
1953	10,408	16
1954	6,671	11
1955	12,335	16
1956	22,620	19
1957	12,037	16
1958	13,324	16
1959	11,021	16
1960	7,240	8
1961	5,869	5

Table 17. Length and age composition of cod landed by German trawlers from the Malangen/Röst area during the period 19. January to 28. April 1961 (‰)

Length, cm	‰	Year-class	‰
45– 49	3	1958	1
50– 54	18	1957	37
55– 59	53	1956	63
60– 64	85	1955	179
65– 69	117	1954	292
70– 74	156	1953	111
75– 79	111	1952	41
80– 84	107	1951	93
85– 89	73	1950	118
90– 94	79	1949	18
95– 99	67	1948	21
100–104	53	before 1948	26
105–109	42		1000
110–114	17		
115–119	8		
120–124	8		
125–129	2		
130–134	1		
	1000		

tion that the catch per day's fishing depicts the total number of cod present in the spawning stock, these figures demonstrate that the strength of the stock of skrei today is only about one-tenth of that of pre-war times.

Table 17 shows the length and age composition of the cod landed from 19. January to 28. April 1961. The average length of the cod increased constantly, from 75 cm in 1956 to 88 cm in 1960. In 1961 the mean length was only 80.5 cm. This variation in average length depicts the appearance and disappearance of the very strong 1950 year-class in the fishery off north-western Norway. This year-class dominated the German catches in the years 1957 to 1960 providing 34%, 33%, 39%, and 34% respectively. In spite of its remarkable strength this year-class was only able to maintain a predominant position for 4 Lofoten seasons. Already in 1961 these 11 year-old cod were reduced to 12% by the high fishing effort in the north-eastern area. At present the very young 1954 (29%) and 1955 (18%) year-classes are the strongest, although only a part of them have reached maturity.

In most cases a sudden rejuvenescense of a spawning stock is an indication of future favourable fishing possibilities. But it is well known that the 1954 year-class is only of medium strength and has been heavily reduced since 1958. When such a year-class, together with a younger and weaker one constitute nearly half of the spawning stock there is evidence for concluding that this stock is very weak. The small numbers of 8 to 12 year-old cod present, which formerly, with less fishing activity, constituted the main part of the stock of spawners is furthermore a symptom of the weakness. The future prospects for cod fishing off the NW Norwegian coast are therefore very bad.

In November an attempt of starting a profitable fishery on the Skolpen Bank was made by some German trawlers. But both the amount caught and the size of the cod were insufficient to sustain a fishery and the trawlers left these waters again. Providing respectively 49% and 26% the 1956 and 1957 year-classes were predominant on the Skolpen Bank. The percentage of older fish was small. The 1954 year-class was represented with 12%. The average length of the total landings was 62.5 cm; the lengths of the 1957, 1956, and 1954 year-classes were 53.6 cm, 61.4 cm, and 78.3 cm respectively.

ARNO MEYER

Baltic Stock

Polish Investigations in the South-Eastern Baltic in 1961

(Table 18)

As usual the spawning of cod began in March. The first spawning males were observed on 10. March on the deepest grounds (below 100 m) of the Gdansk Deep. In April, May and June the spawning activity was very intensive and the climax was observed in May and June (between 60% and 63% of the fish were in stages VI and VII according to the Maier scale). This was the most intensive spawning of cod observed during the last seven years. The rapid post-spawning dispersal of the shoals began in July, spents (stage VIII fish) were, however, observed even in October.

The age composition of the catches in 1961 is presented in Table 18.

Table 18. Percentage age composition (by weight) of the Polish catches of cod in 1961

Age-group	I	II	III	IV	V	VI	VII	VIII
Year-class	1960	1959	1958	1957	1956	1955	1954	1953
% by weight	0.3	13.6	26.7	30.4	20.3	7.6	0.7	0.4

The 1957 year-class (IV-group) was the most abundant, but the 1959 year-class (II-group) was also represented in considerable numbers. Table 18 confirms that the 1958 and 1956 year-classes were poor.

During 1961 the growth-rate of young cod (age-groups I—III) was observed to be insignificantly accelerated. Long experience has shown that the male otoliths are easier to read than those of females, thus 1 to 5% of male otoliths

were rejected as unreadable while 4 to 10% of female ones were rejected. The male sclerites (opaque and transparent zones) are much more visible.

The sex ratio data accumulated during 7 years of observation show that in the Polish catches of cod the females are always prevailing. The average for 1955 to 1961 is 56 females and 44 males in 100 cod in the samples analysed.

St. Rutkowicz

Features of the Cod Spawning in the Baltic in 1961

(Tables 19–23)

In 1961 the cod in the Baltic spawned earlier than usual. The winter was very mild. The temperatures in the south-eastern part of the sea was 1°—1.4°C higher than in previous years. The higher temperatures caused a more rapid development of the gonads, and spawning started therefore 2—3 weeks earlier than in the foregoing year. In April 1961, between 31% and 32% of the cod were spawning.

Spawning was started in March by a considerable part of the cod. In the first half of April, cod larvae of 3.6 to 5.5 mm in length were found in the plankton catches. In colder years cod larvae are not found until May.

Survival of the cod eggs was higher than in the three previous years (see Table 20). According to our opinion this phenomenon is due to an intensive inflow of more saline waters from the North Sea, a high oxygen content (20—31%) in the near-bottom layers of the Gdansk, Bornholm and Gothland Deeps, and a considerable extension of the spawning grounds (Table 21).

Table 21. Salinity (‰) of the near-bottom water layers in the spring season of various years

Locality	1958	1959	1960	1961
Gdansk Deep	10.93	10.96	11.20	12.70
Stolpen Deep	9.0	10.10	11.20	12.40
Bornholm Deep ..	14.25	15.50	15.50	17.60

Table 22. Average number of cod eggs per m² in different localities

Locality	1958	1959	1960	1961
Gdansk Deep	7	17	7	12
Gothland Deep ...	6	9	12	12
Stolpen Deep	—	—	6	7

Table 23. Distribution of cod eggs at different depths in the spring of 1961

Depth, m	Gdansk Deep	Southern Gothland Deep	Bornholm Deep
20–10	—	—	6
50– 20	2	—	8
70– 50	6	2	9
100– 70	12	16	8
130–100	—	10	—

Table 19. Percentage distribution of cod according to maturity stages

Year	Maturity stages II	III	IV	IV–V	V	VI–II	Total
			Gdansk Deep				
1958	15.6	13.5	57.4	—	12.3	1.2	100
1959	12.0	14.0	36.0	—	38.0	—	100
1960	26.0	6.3	24.1	10.0	5.8	27.1	100
1961	9.3	3.0	20.9	15.0	31.0	20.7	100
			Gothland Deep				
1958	7.0	14.0	73.0	—	1.4	2.9	100
1959	6.0	3.0	47.0	—	27.0	2.0	100
1960	7.5	3.2	45.6	19.3	9.9	14.5	100
1961	5.2	6.2	25.0	26.2	32.4	1.2	100

Table 20. Percentage survival of cod eggs in different years*)

Locality	1957 Eggs alive	1957 Eggs dead	1958 Eggs alive	1958 Eggs dead	1959 Eggs alive	1959 Eggs dead	1960 Eggs alive	1960 Eggs dead	1961 Eggs alive	1961 Eggs dead
Gdansk Deep	53	47	30	70	37.7	62.3	26.5	73.5	55	45
Gothland Deep ...	57	43	18	82	33	67	22.2	77.8	34	64
Bornholm Deep ...	30.7	69.3	7	93	42.7	57	—	—	51	49

*) Determination after the method of T. F. Dementjeva (Trudy VNIRO, 34).

Determination of survival of cod eggs shows that in years of increased salinity and high oxygen content of the near-bottom layers the amount of live eggs increases, and vice versa.

In Table 22 data of the average number of cod eggs per m² of sea area are given. In 1961 the average number of cod eggs remained almost at the level of 1960, although the eggs were distributed over a more extensive area. The buoyancy of the eggs increased with the considerable rise in salinity of the near-bottom and intermediate water layers. In Gdansk Deep and the southern part of the Gothland Deep the eggs were distributed down to a depth of 40/50 m, in the Bornholm region down to 10 m (Table 23). In years of lower salinity values the cod eggs are found at depths of 70/80 m.

From the above material it may be assumed that the 1961 year-class of cod will be strong if the time of active feeding for the larvae coincides with an abundance of suitable food organisms. The quantitative analyses carried out in the winter of 1962 seem to give evidence for concluding that enough food is available.

G. B. Grauman

German Investigations in the Western Baltic in 1961

(Tables 24–25)

Trawling experiments with the standard trawl were continued by R/V "Hermann Wattenberg" in February and May, and by a commercial fishing vessel in October 1961 at the same stations in the Kiel Bay as in previous years. The results for cod are shown in Table 24.

In 30 trawling hours 3,951 cod were caught, i.e. 132 fish per hour. In the preceding years the number of cod per 1 hour's fishing were as follows: —

1960 (Feb./June/Oct.)	392
1959 (May/Oct.)	189
1958 (Jan./March/July/Oct.)	61
1957 (Apr./June)	68
1956 (May/June)	31

The mean catch shows a remarkable increase until 1960, and again a decrease to a figure which is still twice that of 1958, if only the years with catches in winter, spring and autumn are considered. The high figures for the two last years

Table 24. Length distribution of cod taken with the standard trawl in the western Baltic in 1961

Month	Number of hauls	Total number of fish caught	Number per 1 hour's fishing, 5 cm groups												Total
			6–10	11–15	16–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	>60	
February	4	1,015	3.0	37.0	21.4	14.6	63.2	42.2	9.0	3.6	3.4	2.2	1.2	2.2	[illegible]
May	15	1,085	1.4	20.3	23.9	8.2	5.1	7.9	4.7	2.4	0.6	0.6	0.4	0.2	[illegible]
October	10	1,851	6.8	19.2	14.8	34.2	23.3	16.4	19.0	14.8	4.6	0.9	0.2	0.1	15[illegible]

Table 25. Number of cod of different year-classes taken with the standard trawl in the western Baltic, 1956–1961

Date		Number of hauls	Number per 1 hour's fishing									
			1953	1954	1955	1956	1957	1958	1959	1960	1961	Total
April/June	1956	14	5.8	7.7	10.6	—	—	—	—	—	—	30.8
October	1956	13	7.3	23.4	36.4	30.0	—	—	—	—	—	100.0
April/June	1957	23	3.9	22.0	29.5	12.0	—	—	—	—	—	68.4
Jan./March	1958	6	0.1	0.5	0.3	1.8	49.2	—	—	—	—	52.0
July	1958	11	0.1	3.8	5.2	9.4	31.6	1.0	—	—	—	51.1
October	1958	7	—	1.2	1.2	4.8	42.0	46.2	—	—	—	95.4
May	1959	3	—	1.0	—	1.0	1.3	55.0	530.0	—	—	588.3
October	1959	11	—	0.1	0.1	1.2	4.1	26.6	30.1	—	—	62.3
February	1960	7	—	1.6	0.8	3.6	13.7	54.8	336.6	—	—	411.1
June	1960	5	—	—	0.6	0.4	1.0	6.6	68.6	—	—	77.2
October	1960	7	—	—	—	0.6	3.2	13.5	169.4	385.0	—	571.7
February	1961	4	—	—	—	0.4	3.2	6.2	129.2	64.0	—	203.0
May	1961	15	—	—	—	0.3	0.1	1.7	18.1	55.5	—	75.7
October	1961	10	—	—	—	—	0.2	2.1	50.3	73.2	28.5	154.3
Weighted mean, 0-group			—	—	—	30.0	49.2	46.2	203.7	268.3	28.5	
Weighted mean, I-group			—	—	23.0	9.9	39.0	40.1	128.5	62.6		
Weighted mean, II-group			—	15.3	23.5	7.1	6.9	9.5	31.0			
Weighted mean, III-group			6.5	17.6	3.6	2.0	2.5	1.9				

are due to the entry of two rich year-classes. This may be seen from Table 25 showing the frequencies of the year-classes in the experimental catches since 1956, when these investigations began.

The frequencies of the year-classes in their first four years of life vary very much from year to year and also within each year .In order to adjust these differences, the weighed means were calculated for the age-groups 0—III of each year-class. The figures obtained give the possibility to estimate the strength of the year-classes constituting the catches in the years 1956—61. The 1959 year-class proves to be the most abundant in this series. The following 1960 year-class is a rich one too, although its frequency as I-group is only half as much. Both year-classes caused the big catches in 1959—61, especially in 1960. The preceding 1957 and 1958 year-classes were normal, the 1956 year-class was poor, as may be seen from the figures representing age-groups I and II.

In the past only the 1955 and 1954 year-classes seem to have been fairly abundant, as may be concluded from the larger figures representing age-groups II and III. The frequency of the older and marketable fish has steadily decreased, but from the rich 1959 and 1960 year-classes a larger surplus of older fish may remain for the next years. The 1961 year-class seems to be only of medium strength.

R. Kändler

HADDOCK

Iceland Stock

German Investigations, 1961

(Table 26)

Fishing for haddock in Iceland waters has become more and more negligible. Haddock are only a by-product of the fishery for cod, saithe and redfish. The most substantial catches of haddock were taken off the SW coast in April and off the NW coast in July and August. The stock on the south-western spawning grounds consisted in 1961 almost of one single year-class; the 1956 year-class made up 67% of the total catch. The average length of these 5 year-old haddock was 57.2 cm (in 1960, 49.1 cm). Off the NW coast the 1957 year-class was predominant providing 48% of the catch, followed by the 1956 and 1959 year-classes.

Arno Meyer

Table 26. Length and age composition of haddock taken by German trawlers in 1961, SW and NW of Iceland (‰)

Length, cm	SW coast	NW coast
30–34	—	5
35–39	—	132
40–44	11	63
45–49	107	128
50–54	218	255
55–59	368	290
60–64	212	74
65–69	53	41
70–74	21	9
75–79	8	3
80–84	2	—
Year-class		
1959	—	179
1958	—	106
1957	144	477
1956	671	211
1955	135	25
1954	16	—
1953	17	—
1952	12	—
1951	4	2
1950	1	—

Arcto-Norwegian Stock

Length and Age Composition and Distribution of Haddock in the Barents Sea, 1961

(Figures 18–19)

The length and age compositions of haddock in the Barents Sea and off the NW coast of Norway were studied by the scientific staff of the Polar Institute from the R.V. "Persey II" and "Tunetz" and the searching trawler "Melitopol".

The length and age composition of haddock in different parts of the Barents Sea is shown in Figure 18. The 4—5 year-old fish, 35—55 cm long, belonging to the 1957 and 1956 year-classes prevailed in the coastal, south-eastern and central areas, and also all over the southern part of the Barents Sea. In the winter of 1961 a number of haddock of the 1959 and 1958 year-classes, 25—35 cm in length, were also present in the western areas, mainly on the slopes of the Murman Bank.

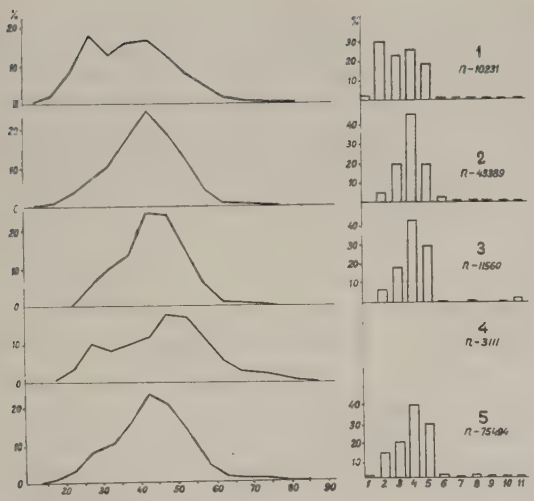

Figure 18. Length (left) and age (right) composition of the haddock in the western (1), coastal (2), south-eastern (3) and central (4) areas and in the entire southern Barents Sea (5) in 1961.

The haddock of the southern Barents Sea were distributed in the following way. In January/March they were scattered over wide areas of the western part of the sea. In April they started moving south-eastwards, forming dense concentrations in the Norwegian Gully, and on the Nordkin, Finnmark, Ribachya, and Kildin Banks. In May the concentrations were observed on the Kildin Bank and in the western and eastern coastal areas. In June and July, haddock were taken in hauls in the inshore and central areas. In August the haddock concentrations were found in the eastern coastal area, on the southern Kanin Bank, and in the north-central area. In the latter, large haddock dominated in the catches; they had apparently arrived there after spawning. In September the shoals extended eastwards, reaching the northern Kanin Bank and the Kanin-Kolguev Shallows. In the second half of September the haddock began leaving the coastal waters, and in October they were found in the Murman Shallows, on the northern Kanin Bank, in the Kanin-Kolguev Shallows, and in the western coastal area. Small concentrations were encountered on the Murman and Kildin Banks. In November the bulk of the fish shifted to the slopes of the Murman Bank. In December haddock were seen in small numbers in the western Barents Sea. The 1959 and 1956 year-classes were observed in the north-central area.

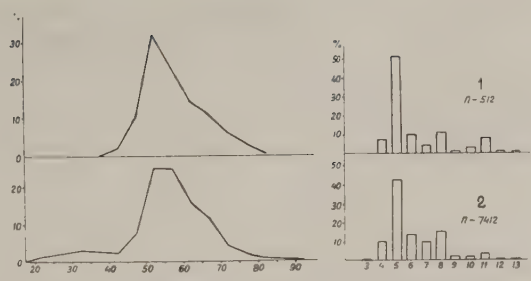

Figure 19. Length (left) and age (right) composition of the haddock in the Kopytov area (1) and off the north-western coast of Norway (2) in 1961.

Haddock of the 1956, 1955, 1954, and 1953 year-classes, 5 to 8 years old and 50 to 65 cm long, prevailed in the samples collected on the spawning grounds off the north-western coast of Norway (Röst and Malangen Banks and the Kopytov area; see Figure 19).

In the north-western areas haddock were found in small numbers. In samples obtained on the western slope of the Bear Island Bank specimens of 25 to 45 cm were predominant.

M. A. Sonina

German Investigations, 1961

(Tables 27–28)

The landings of haddock from the Norwegian Sea have been decreasing since 1956 (Table 27). The average daily catch taken off the Lofotens during the season from January to April has dropped from 6 tons in 1956 to 2.3 tons and 2.8 tons

Table 27. Landings of haddock since the beginning of the German fishery in the Norwegian Sea and the percentage of the total landings taken by the German trawlers

Year	Tons	%
1934	3,703	18
1935	9,182	31
1936	9,024	41
1937	12,436	40
1938	16,686	37
1948	10,419	55
1949	8,108	41
1950	10,526	58
1951	8,036	54
1952	4,679	36
1953	4,453	38
1954	6,475	45
1955	12,513	54
1956	18,112	59
1957	5,631	38
1958	6,084	41
1959	6,779	61
1960	4,464	42
1961	5,029	57

Table 28. Length and age composition of haddock landed by German trawlers from the Skolpen Bank in November 1961 (‰)

Length, cm	‰	Year-class	‰
35–39	5	1958	34
40–44	116	1957	482
45–49	356	1956	443
50–54	290	1955	1
55–59	154	1954	0
60–64	44	1953	24
65–69	16	1952	3
70–74	11	1951	1
75–79	8	1950	11
	1000	1949	0
		1948	1
			1000

in 1960 and 1961. The very rich 1948 and 1950 year-classes have almost disappeared and in 1961 the stock of spawners was chiefly composed of the 1956 and 1953 year-classes, of medium strength, providing 38% and 25% respectively. The average length of the total landings was 60.6 cm, the length of the 1956 and 1953 year-classes was 55.0 cm and 65.6 cm respectively.

Before the war the average catch per day's fishing taken by the German trawlers during the season varied between 2.0 tons and 4.4 tons. When we consider that the fishing power of today's trawlers has risen by 4 times compared with pre-war times (p. 126) it is obvious that the present stock of spawners is only about one-fifth of the pre-war size. Probably the numbers of mature haddock are still lower than those given here because, before the war, the trawlers did not fish at so great depths as today and were not able to work the total range of depths where the migrating haddock are encountered.

As mentioned above (p. 127) a new attempt was made by some German trawlers to take up again the fishery in the Barents Sea, given up since 1958. But as predicted, the yields were small and unremunerative. The landings from the Skolpen Bank in November consisted of two year-classes only, those of 1957 with 48% and 1956 with 44%. The average length of these year-classes was 48.0 cm and 53.8 cm respectively, and the mean length of the total catch was 51.4 cm.

ARNO MEYER

Faroe Stock

Scottish Investigations

(Tables 29–30)

Commercial landings

The average weights of haddock landed per 100 hours' fishing by Aberdeen steam and motor trawlers are shown in Table 29. The mean catch per 100 hours by steam and motor trawler combined is 117 cwt, the same as in 1960.

Market sampling of the Faroe haddock stocks has been continued as in previous years and the data are set out in Table 30.

Age composition

The age composition of the haddock sampled from commercial trawlers is shown in Table 30A. The mean lengths of each year-class are given in Table 30B and in Table 30C are shown the estimated weights of each year-class landed per 10 hours' fishing each month. These were determined by converting the mean lengths in Table 30B to weights (using data from RUSSELL, 1914*) and then by multiplying each by the appropriate number per 10 hours' fishing from Table 30A.

*) RUSSELL, E. S., 1914. Fish. Invest. Lond., Ser. 2, 1 (1).

Table 29. Landings of three size categories of haddock by Aberdeen trawlers from Faroe — 1961

Month	Hrs fishing		Large (Cwt per 100 hrs)		Medium		Small		Total	
	Motor	Steam	Motor	Steam	Motor	Steam	Motor	Steam	Motor	Steam
January	7,739	1,458	14.0	12.2	15.3	12.9	44.8	32.2	74.1	57.3
February	9,387	2,251	16.3	14.1	18.2	18.2	33.7	48.9	68.2	81.2
March	10,102	1,280	14.2	10.2	22.4	18.5	41.9	48.1	78.5	76.8
April	5,951	1,082	21.4	24.7	35.9	35.5	19.2	60.6	126.5	120.8
May	4,589	714	14.7	13.4	19.8	17.2	64.9	72.6	99.4	103.2
June	14,402	1,820	14.0	8.0	16.7	18.6	66.5	63.5	97.2	90.1
July	14,639	1,978	25.2	20.5	40.4	31.6	131.1	108.9	196.7	161.0
August	13,526	1,257	20.8	19.5	27.1	28.2	85.3	84.1	133.2	131.8
September	9,091	854	20.2	14.3	24.0	25.6	72.6	81.1	116.8	121.0
October	8,402	351	18.5	12.0	26.1	16.2	70.5	38.5	115.1	66.7
November	8,112	528	14.2	12.7	27.3	22.5	109.3	59.8	150.8	95.0
December	8,504	594	18.6	15.5	28.9	21.5	82.6	47.5	130.1	84.5
Total/Mean	114,444	14,167	18.0	14.9	25.6	22.4	75.7	64.6	119.3	101.9

Table 30. Aberdeen trawlers' market samples — Faroe haddock 1961

A. Number landed per 10 hours fishing

Brood	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1960	—	—	—	—	—	—	—	—	124.5	196.2	204.5	228.5
1959	106.3	51.6	38.8	18.6	273.5	769.7	1075.1	704.0	783.8	627.9	709.2	857.5
1958	277.9	181.8	253.4	518.1	415.5	356.8	638.4	256.8	243.8	159.0	279.3	174.4
1957	120.8	161.7	195.2	406.8	256.4	91.0	237.1	114.3	95.1	68.2	105.5	69.5
1956	57.8	66.7	82.7	116.7	70.1	31.6	79.0	51.0	29.0	31.3	37.3	15.5
1955	21.5	28.0	20.8	49.6	25.5	16.7	26.3	38.8	9.9	6.6	14.8	9.4
1954	10.8	16.6	13.2	14.9	8.8	9.5	13.4	22.4	6.6	3.2	7.1	2.2
1953	6.0	10.0	6.3	8.9	6.1	5.3	7.9	8.1	2.4	0.8	2.5	0.6
1952	1.6	3.1	2.3	1.6	1.1	2.1	1.6	1.0	0.2	0.2	0.2	0.3
1951 and older	0.7	0.3	0.3	0.3	0.2	0.1	0.7	1.1	0.3	0.1	—	—
Totals	603.4	519.8	613.0	1135.5	1057.2	1282.8	2079.5	1197.5	1295.6	1093.5	1360.4	1357.9

B. Mean lengths (cm) of each age-group sampled

Brood	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1960	—	—	—	—	—	—	—	—	29.2	30.1	30.1	31.0
1959	31.1	31.6	31.1	30.9	31.9	31.5	32.0	34.6	34.2	37.2	37.9	37.1
1958	36.9	37.6	36.5	37.0	37.2	37.9	40.0	42.1	41.4	44.0	44.7	44.7
1957	45.0	43.9	44.2	42.7	44.6	45.3	46.5	48.1	47.1	49.1	48.8	48.9
1956	50.1	49.5	49.9	49.3	47.0	51.6	51.0	51.1	52.8	52.7	52.9	53.6
1955	54.8	55.4	55.0	53.8	53.0	55.2	55.8	52.2	55.2	57.3	58.3	57.4
1954	58.7	59.4	59.2	61.1	59.3	60.1	59.8	58.9	58.0	59.9	64.4	62.5
1953	62.4	62.1	61.1	64.1	62.3	64.8	64.7	64.2	64.2	66.2	67.6	64.9
1952	67.8	65.9	68.9	65.4	72.0	69.1	69.2	71.5	70.9	68.9	70.6	76.0
1951 and older	70.3	69.4	71.1	78.0	67.4	70.0	70.2	73.5	69.1	81.0	—	—

C. Estimated[1]) weights landed per 10 hours fishing (cwt)

Brood	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1960	—	—	—	—	—	—	—	—	0.50	0.89	0.92	1.11
1959	0.51	0.25	0.18	0.08	1.37	3.80	5.63	4.86	5.19	5.45	6.53	7.21
1958	2.30	1.50	1.89	4.13	3.46	3.18	6.84	3.25	2.92	2.36	4.31	2.66
1957	1.76	2.19	2.51	4.90	3.66	1.42	4.06	2.18	1.69	1.39	2.11	1.40
1956	1.26	1.34	1.54	2.16	1.16	0.72	1.77	1.17	0.75	0.80	0.97	0.42
1955	0.63	0.78	0.52	1.22	0.61	0.47	0.79	0.96	0.29	0.22	0.52	0.32
1954	0.39	0.58	0.40	0.54	0.30	0.35	0.49	0.80	0.22	0.12	0.33	0.09
1953	0.25	0.40	0.21	0.39	0.24	0.26	0.37	0.37	0.11	0.04	0.14	0.03
1952	0.08	0.15	0.11	0.07	0.06	0.13	0.09	0.06	0.01	0.01	0.01	0.02
1951 and older	0.04	0.02	0.02	0.02	0.01	0.01	0.04	0.07	0.02	0.01	—	—
Totals	7.22	7.21	7.38	13.51	10.87	10.34	20.08	13.72	11.70	11.29	15.84	13.26

[1]) Using data from RUSSELL, 1914.

The percentage of very old haddock appears to be somewhat less than in previous years and the bulk of the landings was made up of 2—6 year-old fish. There was the usual tendency for the mean lengths to decrease during the spring but this year the effect was far less consistently apparent than it has been in previous years.

R. JONES

North Sea Stock

Scottish Investigations

(Tables 31–34)

Age composition

During 1961 F.R.S. "Scotia" completed three routine surveys over the North Sea using a Vinge trawl in March/April, June and September. The age composition of the haddock captured per 10 hours' trawling is shown in Table 31. The very good 1955 year-class that has been the mainstay of the North Sea haddock fishery for a number of years has almost disappeared and the stock is supported by the moderate to good year-classes of 1958, 1959, and 1960.

0-group haddock (1961 year-class) were caught during the September cruise in extremely large numbers and it seems probable that this is going to be a very good year-class.

Size composition

The mean lengths of the haddock sampled in 1961 are given in Table 32.

British statistics

In Table 33 are given the haddock landings from the North Sea by British motor and steam trawlers during 1960. Comparable statistics for

Table 31. Age composition of haddock caught by F.R.S. "Scotia" in 1961 per 10 hrs trawling

Area	*Northern*				*North Central*			
Cruise	March/Apr.	June	Sept.	All Cruises	March/Apr.	June	Sept.	All Cruises
Number of hauls	12	2	4	18	20	6	18	44
Year-class				Weighted means				Weighted means
1961	—	—	5,075	5,075	—	—	2,941	2,941
1960	112	15	148	109	588	197	168	363
1959	247	50	72	186	282	62	98	177
1958	359	45	358	324	80	23	52	61
1957	29	5	20	24	6	3	4	5
1956	24	15	12	20	5	0	0	2
1955 and older	35	5	98	46	10	5	7	8

Area	*Central*				*Moray Firth and Orkney*		
Cruise	March/Apr.	June	Sept.	All Cruises	March/Apr.	Sept.	All Cruises
Number of hauls	5	3	4	12	8	1	9
Year-class				Weighted means			Weighted means
1961	—	—	2,988	2,988	—	40	40
1960	110	507	515	344	426	310	413
1959	196	623	310	341	34	100	41
1958	60	177	58	89	41	230	62
1957	6	10	5	7	5	10	6
1956	0	7	0	2	0	0	0
1955 and older	22	10	8	14	1	10	2

Note: Moray Firth and Orkney area not sampled in June.

Table 32. Mean lengths (cm) and range of means of haddock of each age-group from the North Sea in 1961

Year-class	Age	Area / Cruise	*Northern* Mean	Range of means	No. of fish	*North Central* Mean	Range of means	No. of fish	*Central* Mean	Range of means	No. of fish	*Moray Firth and Orkney* Mean	Range of means	No. of fish
1961	0+	Sept.	12.5	11.2–13.2	2,030	13.5	11.6–15.0	5,294	13.8	12.4–16.2	1,195	15.2	15.2	4
1960	1+	March/Apr.	21.7	18.7–24.0	134	18.9	17.5–20.0	1,175	19.6	17.5–20.4	55	20.5	18.0–24.0	341
		June	23.3	23.3	3	23.0	22.5–23.6	118	21.3	17.0–24.8	152	—		
		Sept.	28.7	28.0–29.1	59	27.6	24.7–31.5	302	28.1	26.0–30.0	206	29.7	29.7	31
1959	2+	March/Apr.	28.9	25.5–30.7	296	29.3	27.3–30.6	565	32.4	30.5–35.0	98	31.3	28.5–34.5	27
		June	32.1	30.2–34.0	10	31.6	30.1–33.0	37	32.5	32.4–32.6	187	—	—	—
		Sept.	33.2	32.4–34.8	29	34.0	30.3–38.0	177	33.8	31.0–35.2	124	34.8	34.8	10
1958	3+	March/Apr.	32.8	29.2–33.9	431	35.5	28.4–38.8	160	38.6	37.4–39.3	30	33.0	30.8–37.0	33
		June	32.2	32.2	9	39.2	35.5–45.0	14	37.2	36.8–37.5	53	—		
		Sept.	34.9	32.8–36.3	143	37.2	34.5–42.0	93	38.2	36.0–40.0	23	34.7	34.7	23
1957	4+	March/Apr.	37.2	36.5–38.0	35	39.0	33.0–43.0	12	41.5	37.0–46.0	3	39.5	34.0–39.0	4
		June	33.0	33.0	1	40.0	40.0	2	41.0	41.0	3	—	—	—
		Sept.	38.9	37.0–41.5	8	37.9	34.0–45.5	8	39.0	39.0	2	45.0	45.0	1
1956	5+	March/Apr.	37.1	31.0–42.0	29	36.6	35.1–38.0	10	—	—	0	—	—	—
		June	39.5	36.0–43.0	3	—	—	0	40.5	40.5	2	—	—	—
		Sept.	39.0	38.0–40.0	5	—	—	0	—		0	—	—	0
1955	6+	March/Apr.	43.4	41.3–47.0	39	45.0	38.0–52.0	19	45.1	45.1	9	46.0	46.0	1
		June	45.0	45.0	1	45.8	42.5–49.0	3	43.0	43.0	1	—		—
		Sept.	41.8	38.7–44.6	34	43.2	41.0–46.5	11	51.0	51.0	1	45.0	45.0	1

Scottish motor and steam trawlers during 1961 are given in Table 34. Landings per 100 hours' fishing by Scottish steam trawlers from April to December 1961, were lower than those in the comparable periods and areas of 1960.

R. Jones

Rockall Stock

English Investigations

(Tables 35–38)

During 1961 the R. V. "Ernest Holt" visited the Rockall Bank on two trips. In April only eight

Table 33. Landings of haddock by British motor trawlers from the North Sea in 1960
(Landings by British steam trawlers in parentheses)

Quarterly period	North of Lat. 57°30′N Weight landed (100 cwt)	100 hrs fishing	Weight landed/ 100 hrs	Lat. 55°N to 57°30′N Weight landed (100 cwt)	100 hrs fishing	Weight landed/ 100 hrs
Jan.–Mar.	275 (312)	241 (253)	114 (123)	29 (115)	77 (253)	38 (45)
Apr.–June	294 (279)	221 (171)	133 (163)	76 (136)	492 (321)	15 (42)
July–Sept.	222 (136)	177 (106)	125 (128)	328 (263)	608 (289)	54 (91)
Oct.–Dec.	585 (231)	407 (154)	144 (150)	213 (185)	430 (194)	50 (95)

Quarterly period	South of Lat. 55°00′N Weight landed (100 cwt)	100 hrs fishing	Weight landed/ 100 hrs	All Areas Weight landed (100 cwt)	100 hrs fishing	Weight landed 100 hrs
Jan.-Mar.	1 (3)	1022 (591)	+ (1)	306 (430)	1340 (1098)	23 (39)
Apr.–June	5 (6)	476 (447)	1 (1)	374 (422)	1188 (938)	31 (45)
July–Sept.	32 (70)	529 (527)	6 (13)	581 (468)	1314 (923)	44 (51)
Oct.–Dec.	36 (34)	718 (538)	5 (6)	834 (451)	1555 (887)	54 (51)

Table 34. Landings of haddock by Scottish motor trawlers from the North Sea in 1961
(Landings by Scottish steam trawlers in parentheses)

Quarterly period	North of Lat. 57°30′N Weight landed (100 cwt)	100 hrs fishing	Weight landed/ 100 hrs	Lat. 55°N to 57°30′N Weight landed (100 cwt)	100 hrs fishing	Weight landed/ 100 hrs	All Areas Weight landed (100 cwt)	100 hrs fishing	Weight landed/ 100 hrs
Jan.-Mar.	463 (112)	283 (84)	164 (133)	106 (34)	111 (51)	95 (67)	569 (146)	394 (135)	144 (108)
Apr.–June	200 (43)	122 (29)	164 (148)	172 (35)	236 (50)	73 (70)	373 (78)	359 (80)	104 (98)
July–Sept.	285 (42)	206 (32)	138 (131)	347 (32)	311 (30)	112 (107)	632 (74)	517 (62)	122 (119)
Oct.–Dec.	528 (48)	374 (44)	141 (109)	233 (8)	270 (14)	86 (57)	761 (56)	644 (57)	118 (98)

Table 35. Length composition of Rockall haddock caught by R. V. "Ernest Holt" in June 1961

Length group (cm)	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55+	Total
Number of fish	74	146	2,900	2,550	366	17	4	2	6,059

Table 36. Age composition of Rockall haddock caught by R. V. "Ernest Holt" in June 1961

Age-group	1	2	3	4	5	6	7	8	9	10 and older
%	2.9	0.1	1.0	6.9	0.8	23.6	49.5	10.8	1.9	2.2

Table 37. Age/length key for Rockall haddock caught by R. V. "Ernest Holt" in June 1961

Length (cm) \ Age	1	2	3	4	5	6	7	8	9	10 and older	Total
20–24	19	—	—	—	—	—	—	—	—		19
25–29	25	1	2	5	—	2	—	—	—	—	35
30–34	—	—	1	6	—	14	26	3	—	—	50
35–39	—	—	—	1	1	11	26	7	2	2	50
40–44	—	—	—	—	—	5	17	13	1	4	40
45–49	—	—	—	—	—	2	3	1	—	—	6
50–54	—	—	—	—	—	—	—	—	2	1	3
55					—					2	2
Total	44	1	3	12	1	34	72	24	5	9	205

Table 38. English total catch and catch per 100 hours' trawling on Rockall Bank, 1928–1961

Year	Mean 1928–32	Mean 1933–38	Mean 1945–49	Mean 1950–54	1955	1956–58	1959	1960	1961
Total catch (cwt)	44,365	121,066	62,202	55,669	6,671	No trawl landings	537	No trawl landings	995
Catch/100 hours all fish ..	380	384	675	577	638	—	269	—	442
Catch/100 hours haddock	248	253	422	348	220	—	91	—	74

trawl hauls were made, but in June an extensive survey was carried out. The length and age compositions of the haddock caught during the June survey are given in Tables 35 and 36. The age/length relation is shown in Table 37. Almost half the catch belonged to the 1954 year-class. The 1955 and 1953 year-classes are the next strongest, but none of the past five year-classes is abundant.

Table 38 gives the mean English landings from the Rockall Bank from 1928/32 until 1961.

R. W. Blacker

WHITING

North Sea Stock

Scottish Investigations

(Tables 39–42)

Age composition

The age composition of the whiting captured by F. R. S. "Scotia" in the North Sea during 1961 is shown in Table 39. Three routine trawling cruises were made during the year, but the Moray Firth and Orkney area was not visited during the June cruise. The 1959 year-class was well represented in all areas, while there were big catches of the 1960 year-class in the Central and Moray Firth and Orkney areas during the spring and summer cruises.

Size composition

The mean lengths of whiting sampled in the North Sea during 1961 are given in Table 40.

British statistics

A summary of the whiting landings by British motor and steam trawlers from the North Sea in 1960 is given in Table 41. The landings by Scottish trawlers during 1961 are given in Table 42.

R. Gambell

Table 39. Age composition of whiting caught by F. R. S. "Scotia" in 1961 per 10 hrs trawling

Area	*Northern*				*North Central*				*Central*				*Moray Firth and Orkney*		
Cruise	March/ April	June	Sept.	All cruises	March/ April	June	Sept.	All cruises	March/ April	June	Sept.	All cruises	March/ April	Sept.	All cruises
Number of hauls	12	2	4	18	20	6	18	44	5	3	4	12	8	1	9
Year-class				Weighted means				Weighted means				Weighted means			Weighted means
1961	—	—	2	2	—	—	238	238	—	—	363	363	—	70	70
1960	2	0	15	5	132	7	304	185	886	3,337	480	1,363	526	0	468
1959	222	10	28	155	418	77	519	413	166	2,347	738	902	234	20	210
1958	138	40	8	98	146	13	147	128	24	443	240	201	81	0	72
1957	38	15	5	28	46	5	29	33	12	20	72	34	38	0	34
1956	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0
1955 and older	4	0	0	3	1	0	5	2	4	0	0	2	2	0	2

Note: Moray Firth and Orkney area not sampled in June.

Table 40. Mean lengths (cm) and range of means of whiting of each age-group from the North Sea in 1961

Year-class	Age	Area / Cruise	*Northern* Mean	Range of means	No. of fish	*North Central* Mean	Range of means	No. of fish	*Central* Mean	Range of means	No. of fish	*Moray Firth and Orkney* Mean	Range of means	No. of fish
1961	0+	Sept.	16.0	16.0	1	14.1	11.6–16.2	428	13.6	13.5–15.0	121	16.6	16.6	7
1960	1+	March/Apr.	21.0	19.0–24.0	3	18.1	14.2–22.7	263	16.8	15.0–20.7	443	18.5	16.6–22.0	421
		June	—	—	0	20.8	18.0–21.7	4	23.5	23.5	1,001	—	—	—
		Sept.	28.8	28.8	6	26.1	23.5–27.3	547	26.8	23.4–27.1	160	—	—	0
1959	2+	March/Apr.	25.7	24.0–27.7	266	25.0	24.1–28.0	837	24.9	22.7–25.9	83	25.9	25.1–31.0	187
		June	27.5	27.0–28.0	2	26.0	25.0–27.0	46	28.5	25.0–28.5	704	—	—	—
		Sept.	32.7	29.0–35.0	11	29.3	28.1–32.3	934	29.4	28.9–30.0	246	31.5	31.5	2
1958	3+	March/Apr.	28.7	27.9–31.6	165	27.9	26.0–29.6	292	27.3	26.0–28.0	12	27.1	26.8–30.5	65
		June	32.9	32.0–33.0	8	30.7	26.0–31.8	8	28.1	28.1	133	—	—	—
		Sept.	32.3	32.0–32.5	3	31.3	28.5–35.1	264	30.9	29.9–31.1	80	—	—	0
1957	4+	March/Apr.	30.7	29.0–38.0	45	29.6	27.0–34.0	92	32.1	32.0–33.0	6	30.9	28.6–41.0	30
		June	32.7	32.7	3	30.3	30.0–30.5	3	34.0	34.0	6	—	—	—
		Sept.	33.5	33.5	2	35.8	32.0–41.0	53	32.8	32.8–33.0	24	—	—	0
1956	5+	March/Apr.	—	—	0	—	—	0	—	—	0	—	—	0
		June	—	—	0	—	—	0	—	—	0	—	—	—
		Sept.	—	—	0	38.0	35.0–45.0	4	—	—	0	—	—	0
1955	6+	March/Apr.	34.4	29.0–36.0	5	31.5	30.0–33.0	2	40.5	33.0–48.0	2	36.5	34.0–39.0	2
		June	—	—	0	—	—	0	—	—	0	—	—	—
		Sept.	—	—	0	39.9	33.0–42.0	8	—	—	0	—	—	0

Table 41. Landings of whiting by British motor trawlers from the North Sea in 1960
(Landings by British steam trawlers in parentheses)

Quarterly period	North of Lat. 57°30′N: Weight landed (100 cwt)	100 hrs. fishing	Weight landed/100 hrs	Lat. 55°N to 57°30′N: Weight landed (100 cwt)	100 hrs. fishing	Weight landed/100 hrs
Jan.–Mar.	155 (180)	241 (253)	64 (71)	24 (63)	77 (253)	31 (25)
Apr.–June	41 (44)	221 (171)	19 (26)	11 (19)	492 (321)	22 (6)
July–Sept.	52 (40)	177 (106)	29 (38)	61 (61)	608 (289)	10 (21)
Oct.–Dec.	98 (45)	407 (154)	24 (29)	57 (26)	430 (194)	13 (13)

Quarterly period	South of Lat. 55°00′N: Weight landed (100 cwt)	100 hrs. fishing	Weight landed/100 hrs	All Areas: Weight landed (100 cwt)	100 hrs. fishing	Weight landed/100 hrs
Jan.–Mar.	39 (17)	1022 (591)	4 (3)	218 (261)	1340 (1098)	16 (24)
Apr.–June	13 (11)	476 (447)	3 (2)	65 (74)	1188 (938)	5 (8)
July–Sept.	31 (21)	529 (527)	6 (4)	144 (122)	1314 (923)	11 (13)
Oct.–Dec.	22 (9)	718 (538)	3 (2)	177 (81)	1555 (887)	11 (9)

Table 42. Landings of whiting by Scottish motor trawlers from the North Sea in 1961
(Landings by Scottish steam trawlers in parentheses)

Quarterly period	North of Lat. 57°30′N: Weight landed (100 cwt)	100 hrs fishing	Weight landed/100 hrs	Lat. 55°N to 57°30′N: Weight landed (100 cwt)	100 hrs fishing	Weight landed/100 hrs	All Areas: Weight landed (100 cwt)	100 hrs fishing	Weight landed/100 hrs
Jan.–Mar.	154 (46)	283 (84)	54 (55)	44 (10)	111 (51)	40 (20)	198 (56)	394 (135)	50 (41)
Apr.–June	49 (9)	122 (29)	40 (31)	66 (12)	236 (50)	28 (24)	116 (21)	359 (80)	32 (26)
July–Sept.	125 (25)	206 (32)	61 (78)	171 (17)	311 (30)	55 (57)	296 (41)	517 (62)	57 (66)
Oct.–Dec.	322 (29)	374 (44)	86 (66)	108 (3)	270 (14)	40 (21)	430 (32)	644 (57)	67 (56)

Baltic Stock

German Investigations in the Western Baltic, 1961

(Tables 43–44)

The trawling experiments taken up in 1956, were continued in 1961. Catches with the standard trawl were carried out in February, May, and October at the same places in the Kiel Bay as in the previous years. The results for whiting are shown in Table 43.

In 30 trawling hours 460 whiting were caught, i.e. 18 fish per hour. In the preceding years the numbers of whiting in 1 hour's fishing were as follows:—

1960 (Feb./June/Oct.)	133
1959 (May/Oct.)	35
1958 (Jan./March/July/Oct.)	44
1957 (April/June)	9
1956 (May/June/Oct.)	59

The mean catches fluctuate from year to year as different quantities of young whiting migrate during the autumn from northern waters into the western Baltic (Table 44).

In the autumn and winter of each year, great quantities of the youngest year-class (0-group) are caught in the Kiel Bay. The mean catches per hour vary between 51 and 78, with the exception of the two last year-classes, of which the 1960 year-class was exceptionally frequent, whereas the 1961 year-class seems to be poorly represented. In some years the small whiting outnumber the cod of the same year-class (see p. 129, Table 25). But in late spring and early summer, the number of whiting decreases to a striking extent. In the catches of May/June 1957—61, very few whiting were caught, 1—9 specimens per hour. The mean catch of one year-old fish decreased to 5.9, against 70 in October. The question arises whether the small whiting leave the western Baltic in the spring and migrate back to northern waters, or avoid the bottom water and chiefly stay in higher water layers where they cannot be caught by trawl. The latter is more probable as the catch of I-group whiting and older ones per unit effort often increases again from May/June to October. Otherwise we must presume that many fish return to the western Baltic again in the autumn, together with the immigrating 0-group.

R. Kändler

Table 43. Length distribution of whiting taken with the standard trawl in the western Baltic in 1961

Month	Number of hauls	Total number of fish caught	Number per 1 hour's fishing, 5 cm groups 6–10	11–15	16–20	21–25	26–30	31–35	36–40	Total
February ..	4	139	0.2	10.8	13.4	1.8	0.8	0.8	—	27.8
May	15	33	0.0	0.5	0.8		0.1		—	1.4
October ...	10	288	9.8	9.0	5.0	0.9	3.8	0.2	0.1	28.8

Table 44. Number of whiting of different year-classes taken with the standard trawl in the western Baltic, 1956–61

Date	Number of hauls	Number per 1 hour's fishing 1954	1955	1956	1957	1958	1959	1960	1961	Total
May/June 1956	14	0.3	29.9	—	—	—	—	—	—	30.3
October 1956	13	7.0	25.0	56.8	—	—	—	—	—	90.0
Apr./June 1957	23	0.6	2.0	6.5	—	—	—	—	—	9.1
Jan./March 1958	6	—	0.5	3.0	50.7	—	—	—	—	54.2
July 1958	11	—	—	0.6	6.7	—	—	—	—	7.3
October 1958	7	—	0.2	3.0	13.4	78.0	—	—	—	94.6
May 1959	3	—	—	—	0.3	7.0	—	—	—	7.3
October 1959	11	—	—	—	1.8	4.0	37.0	—	—	42.8
February 1960	7	—	—	—	0.7	4.0	109.9	—	—	114.6
June 1960	5	—	—	—	—	0.6	4.0	—	—	4.6
October 1960	7	—	—	—	—	—	15.0	215.3	—	230.3
February 1961	4	—	—	—	0.4	0.4	0.8	26.2	—	27.8
May 1961	15	—	—	—	—	—	0.1	1.3	—	1.4
October 1961	10	—	—	—	—	0.1	0.2	4.6	23.9	28.8
Weighted mean, 0-group		—	—	56.8	50.7	78.0	65.4	146.5	23.9	
Weighted mean, I-group		—	27.5	5.8	9.3	4.4	8.0	2.6		
Weighted mean, II-group		3.5	1.7	1.5	1.2	0.3	0.1			

Herring

INTRODUCTION

The contributions included in this volume are as follows:—

Distant Northern Seas

Iceland:	a) J. Jakobsson b) O. J. Østvedt
Norway:	a) F. Devold & O. J. Østvedt b) O. Dragesund c) O. Dragesund
U.S.S.R.:	I. G. Yudanov

Near Northern Seas

1. Adolescent herring investigations

Denmark[1]):	Aage J. C. Jensen
Germany:	a) P.F. Meyer-Waarden b) K. Tiews
Scotland:	A. Saville

2. Adult herring investigations

Belgium:	Ch. Gilis
Denmark[2]):	Aage J. C. Jensen
Netherlands:	K. H. Postuma & J. J. Zijlstra
Scotland:	B. B. Parrish, A. Saville, I. G. Baxter & G. McPherson

Skagerak, Kattegat and Baltic-Belt Seas

Denmark:[2])	Aage J. C. Jensen
Poland:	J. Popiel

The most striking feature of the *Distant Northern Seas* herring fisheries in 1961 was the continuation of the decline of the Norwegian and Soviet Atlanto-Scandian herring fisheries. In both fisheries the catches were less than in 1960 and earlier years; in fact, the Norwegian catch was the poorest since 1902. The Norwegian and Soviet contributions show that recruitment was again poor, giving a sequence of up to seven consecutive poor year-classes as the main cause of the decline, and a relatively old exploited stock dominated by the 1950 year-class. The lateness and northerliness of the Norwegian fishery are important, associated phenomena.

In contrast, the summer fishery off the north coast of Iceland showed a considerable improvement over recent years. This, together with a successful new winter-spring fishery off the south and west coasts, and a relatively good autumn season, resulted in a substantial increase in the total Icelandic yield to a record of 324,000 tons. Norwegian and Icelandic spring spawners both contributed significantly to the successful summer fishery, and again the Norwegian spring spawning component was composed principally of old fish, with the 1950 year-class predominating.

In the *Near Northern Seas*, one of the most important features was the marked improvement in the fishery in the southern North Sea; both the drift-net (East Anglian) and trawl (Sandettié and Channel) fisheries were more productive than in recent years. As shown in the Dutch contribution, this was due to good recruitment by the 1958 year-class. In contrast, recruitment to the northern North Sea fisheries was relatively poor, resulting in reduced catches in the recruitment areas (e. g. Buchan). In this region, the fisheries were centred on an older, adult stock in which the 1956 year-class once more predominated. It is significant that the Danish adolescent herring contributions report the presence of large concentrations of young North Sea autumn spawners along the Kattegat coast of northern Jutland in 1961, whilst the German and Scottish contribution points to poor production in the German Bight and Scottish coastal areas.

B. B. Parrish

[1]) & [2]) The Danish material for the North Sea, Skagerak, Kattegat, Belt Sea and Baltic are included within the one contribution.

A. Distant Northern Seas

Young Stages

Norwegian Small and Fat Herring Investigations in 1961

(Figures 1–2; Tables 1–2)

The total landings of immature herring in Norway in 1961 amounted to 3.700 mill. hectolitres, 2.550 mill. hl being taken as small herring and 1.150 mill. hl as fat herring and 'forfangstsild'. The landings in different areas are shown in Table 1.

It will be seen that 85.8% of the small herring were caught in northern Norway (Finnmark, Troms and Nordland), 10.3% in Trøndelag and Møre and 3.9% south of Stad (Sogn and Fjordane, Hordaland and Rogaland). The corresponding figures in 1960 were 78.4%, 16.2% and 5.4% respectively. During the first part of the year the 1960 year-class predominated in the small herring catches, whereas the 1961 year-class dominated during the last three months of the year. The yield of the latter year-class, however, was considerably less than the output of the 1960 year-class in the same period in the previous year.

Table 1. The landings of immature herring in Norway in 1961

Area	Small herring mill. hl	Small herring %	Fat herring mill. hl	Fat herring %
Finnmark-Troms Nordland	2.187	85.8	1.006	87.5
Trøndelag-Møre ..	0.262	10.3	0.135	11.7
Sogn and Fjordane Hordaland-Rogaland	0.101	3.9	0.009	0.8
Total	2.550	100.0	1.150	100.0

As shown in Table 1, 87.5% of the fat herring were taken in northern Norway, 11.7% in Trøndelag and Møre, and only 0.8% south of Stad. The corresponding figures of the three districts in 1960 were 53.0%, 43.1% and 3.9% respectively. The

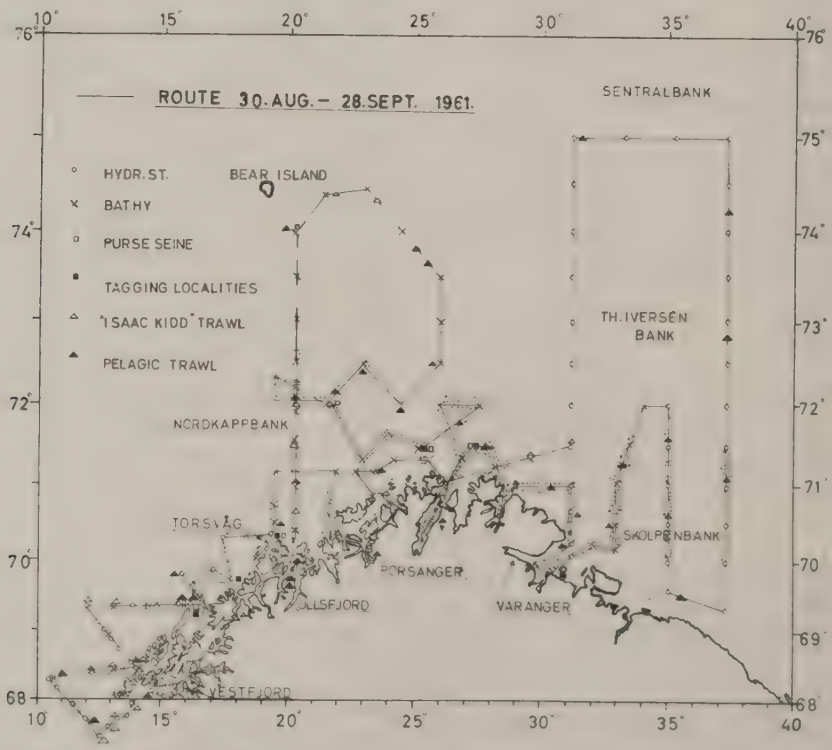

Figure 1. The routes and grid of stations of the R. V. "G. O. Sars" in August/September 1961. The distribution of the herring is also shown, the records being marked as dots on each side of the course line (scattered) and lines across the course line (dense).

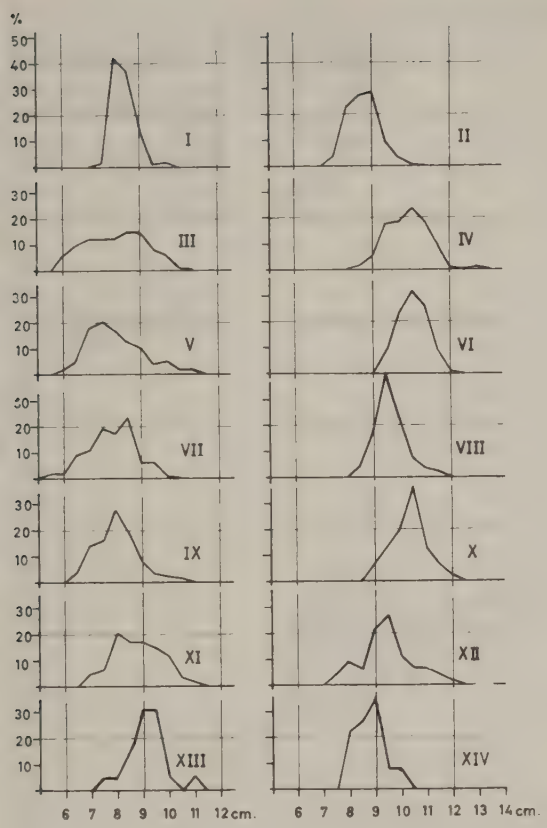

Figure 2. The length distribution of the 0-group.

I = Røst Bank
II = Eidsfjord
III = Malangen
IV = Hekkingen
V = Ullsfjord
VI = Hamarfjord (Torsvåg)
VII = Alta
VIII = Loppa
IX = Porsangerfjord
X = North Cape Bank
XI = Varanger
XII = North Bank
XIII = Kildin Bank
XIV = Skolpenbank

Table 2. Age composition of fat herring (%)

Area	Age (winter-rings) 1	2	3	4	Total
Finnmark-Troms Nordland	55.0	42.3	2.4	0.3	100
Trøndelag-Møre ..	97.9	2.1	—	—	100
Sogn and Fjordane Hordaland-Rogaland	98.9	1.1	—	—	100

age composition of the fat herring is given in Table 2. The samples from the southernmost districts consisted almost entirely of the 1960 year-class. This same year-class also predominated in the catches in northern Norway, together with the 1959 year-class.

From the end of August to the end of September a cruise was undertaken with R. V. "G. O. Sars" to the area off northern Norway and in the Barents Sea, to investigate the distribution of the immature herring, especially the 0- and I-groups. The routes of the research vessel and the records of herring obtained by asdic and echo-sounder are shown in Figure 1. R. V. "G. O. Sars" was equipped with purse seine and pelagic trawl, which made it possible to secure samples of the herring observed, the length composition of the 0-group being shown in Figure 2.

According to the records obtained and the fishery experiments carried out, it is likely that the 1961 year-class is weaker than the 1960 and 1959 year-classes.

Olav Dragesund

Adult, Commercial Fish

The Icelandic Herring Fishery in 1961

(Figures 3–4; Tables 3–11)

1. Commercial

The year started with a new and successful winter and spring season. The winter season lasted from the beginning of the year to the end of February. The spring season began at the end of March and lasted until the middle of June.

The fishing area extended from about the middle of the west coast (Snæfellsnes) to the east of the Vestmannaeyjar on the south coast. The number of boats varied from 8 in February/April to 58 in May and the first half of June. Practically all the boats were equipped with nylon purse seines, puretic power blocks and asdics for horizontal ranging. At the close of the season the total catch reached 38,000 tons.

It is a pleasure to record that, in 1961, the north and east coast summer season was quite good for the first time since 1944. The total catch of 212,000 tons is the highest Icelandic purse seine yield ever recorded. The total catch and catch per purse seine in the years 1959/61 were as follows:—

North coast fishery

Year	Catch, 1,000 tons	Catch per purse seine, 1,000 tons
1959	154	0.67
1960	108	0.42
1961	212	0.98

Comparing the catch per purse seine of 0.98 thousand tons in 1961 with the 10 'good years' before 1945 it is revealed that, in spite of the great advance in fishing technique, five of these give yield figures per purse seine above the 1961 level. The striking difference is, however, that only 8.2% of the catch of 1961 was taken on the old and traditional fishing grounds off the north coast. The east coast fishing grounds yielded 67.5% of the total catch and the remaining 24.3% were taken in a far offshore area never fished before 1945.

With an increasing number of boats equipped with puretic power blocks the autumn season was also quite successful. The season lasted from mid-October to the end of the year. The number of boats which took part in this season varied from a few in October to about 100 during late November and December. At the end of the year the total catch had reached about 70,000 tons of herring, all fished off the south-west coast. During late autumn a small herring fishery, yielding about 4,000 tons, took place in Eyjafjörđur Fjord on the north coast.

Thus the total Icelandic yield in 1961 reached the record figure of 324,000 tons.

Table 3. Length distribution of north and east coast herring

(‰)

	A	B	C	D	
Sample nos.	2 4–10 34	1, 3 11–20 25, 29–30	21–24 26–28 31–33 35–53 55–58	54	Total
Length, cm					
41	—	1	—	—	—
40	4	4	—	—	2
39	9	29	4	—	12
38	61	139	37	2	71
37	143	264	128	4	172
36	125	331	277	3	265
35	104	182	272	2	215
34	100	38	132	1	101
33	101	9	40	1	44
32	117	2	26	—	39
31	57	1	21	—	23
30	15	—	24	3	16
29	4	—	20	3	12
28	—	—	17	1	10
27	—	—	2	10	1
26	—	—	—	28	2
25	—	—	—	27	6
24	—	—	—	11	2
23	—	—	—	4	1
Total	1000	1000	1000	1000	1000
Number of fish	840	1335	2492	100	4787
Mean	34.67	36.35	34.91	26.01	35.12

2. Biological

(a) *North and east coast*

The material collected in 1961 comprised 58 samples, containing 4,795 fish. One of the samples (No. 54) consisted mainly of small and immature herring but otherwise the samples have been grouped, as shown in Figure 3, into the following three main categories:— (A) samples 2, 4—10 and 34, from fishing grounds off the western part of the north coast; (B) samples 1, 3, 11—20, 25, 29 and 30, from the far offshore waters off the eastern part of the north coast; (C) samples 21—24, 26—38, 31—33, 35—53 and 55—58, from east coast fishing grounds. In relation to the total catch, the first group only represents 8.2%, the second 24.3% and the third 67.5% of the total. Figure 3 shows the geographical distribution of these three groups.

The length distributions of the samples from each area are shown in Table 3. These data show that group B consisted exclusively of very large herring, whereas smaller herring were represented to some degree in group C (east coast). Group A (western north coast), on the other hand, had a bimodal length distribution with the smaller herring so well represented that its mean was 0.45 cm below the overall mean of 35.12 cm.

Figure 3. Geographical distribution of herring samples in 1961. Open circles = samples from the SW coast autumn fishery.

Table 4. Relative strength of the tribes

	A	B	C	Total
NN	25	425	325	294
SN	1	180	93	99
ISPR	960	392	566	595
ISUM	14	3	16	11
	1000	1000	1000	1000

A, B, C = See section in Fig. 3 and text
NN = Northern Norwegian type
SN = Southern Norwegian type
ISPR = Icelandic Spring Spawners
ISUM = Icelandic Summer Spawners

The relative strengths of the four tribes as identified by scale analyses are shown in Table 4. It is clear that, at the beginning of the season (19. to 26. June) there was an invasion of Icelandic spring spawners onto the western fishing grounds. The proportion of Norwegian herring in this group was no more than is customary in Icelandic spawning populations. This invasion was closely followed by another into the far offshore waters off the middle and eastern north coast. Table 4 also shows that, although considerably mixed with Icelandic spring spawners, this invasion was dominated by Norwegian herring. The catches and asdic recordings during the season showed that of these two invasions the latter was by far the strongest. In spite of its strength and very large shoals during late June and early July, this 'Norwegian' invasion dispersed before mid-July, so that without the third invasion of herring, the 1961 season would have been yet another failure. This last invasion entered the east coast fishing grounds on 10. July and from then on, to the close of the season, practically all the fishing took place off the east coast. Table 4 shows that this invasion (group C) consisted of both Norwegian (417‰ and Icelandic (583‰) herring, yielding 67.5% of the total catch.

Comparing the relative strength of tribes in 1961 with the previous years it appears that the Norwegian tribes increased from 237‰ to 390‰. One has to go as far back as 1956 to find the Norwegian tribes so well represented in the north and east coast samples.

The age composition of the tribes is shown in Table 5 and Figure 4. There were 21 year-classes in the samples, ranging in age from 2 to 22 years. The same year-classes predominated as in 1960 (see Ann. Biol, **17**).

The 1950 year-class in the northern Norwegian (NN) tribe increased from 415‰ in 1960 to 591‰ in 1961; similarly, in the southern Norwegian tribe (SN), this year-class increased from 389‰ in 1960 to 575‰ in 1961. It should be noted that in 1961 the 'marked' group of the 1950 year-class (N_6, with six

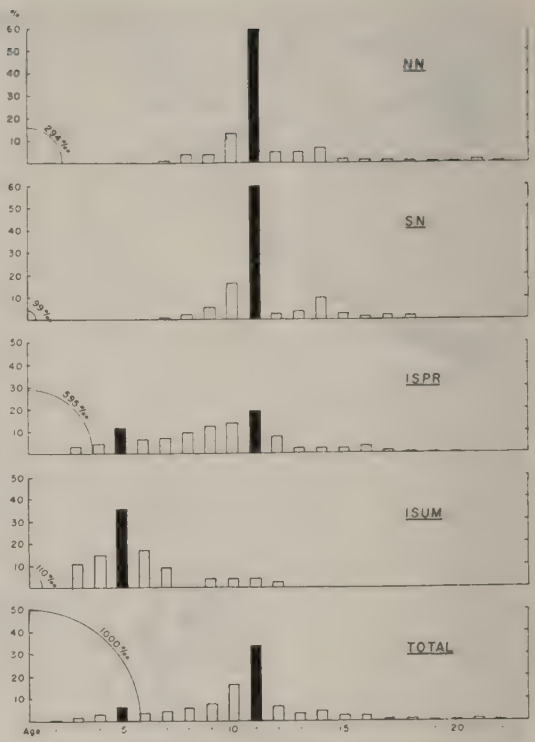

Figure 4. Percentage age compositions of the north and east coast herring in 1961.

coastal rings) became important for the first time in Icelandic catches. Considering the Icelandic spring spawners (ISPR) it should be noted that in 1960 the 1956 year-class reached the unusual abundance of 149‰ at only 4 years of age. In 1961, however, it only reached 115‰. This was due to the fact that the first migration from western Iceland, where this year-class predominated, proved only a weak one as compared with the later, but very strong, invasion of older Icelandic spring spawners to the east coast, where the 1950, 1951 and 1952 year-classes predominated. During the summer season, Icelandic summer spawners were of very little importance in the north and east coast catches but 5-ringers, yielding 354‰ of this tribe predominated in this population.

Table 6. Average amount of *Calanus* (cm²) in the herring stomachs in 1961

17.–20. June	7.8
21.–30. June	10.8
1.–10. July	14.4
11.–20. July	16.7
21.–31. July	18.6
1.–10. August	14.0

Table 5. Age distributions of north and east coast herring in 1961 (‰)

Age	Year-class	NN	SN	ISPR	ISUM	?	Sample no. 54	Total
2	1959	—	—	+	—	—	833	19
3	1958	—	—	37	104	18	42	23
4	1957	—	—	48	146	—	31	30
5	1956	—	—	115	354	18	—	70
6	1955	—	—	62	166	35	—	38
7	1954	10	2	63	83	18	21	41
8	1953	38	22	90	—	53	—	65
9	1952	30	50	114	42	123	—	81
10	1951	128	160	130	42	140	31	130
11	1950	591	575	190	42	296	42	338
12	1949	43	25	70	—	35	—	55
13	1948	43	30	19	21	53	—	27
14	1947	57	97	15	—	123	—	36
15	1946	18	22	18	—	53	—	18
16	1945	14	5	22	—	—	—	16
17	1944	13	7	4	—	35	—	7
18	1943	4	5	1	—	—	—	2
19	1942	2	—	1	—	—	—	1
20	1941	2	—	1	—	—	—	1
21	1940	6	—	—	—	—	—	2
22	1939	1	—	—	—	—	—	+
Total		1000	1000	1000	1000	1000	1000	1000
Number of fish		1187	401	2401	48	650	100	4787
‰		294	99	595	11	—	—	1000
Mean age		11.3	11.2	8.7	5.7	—	2.9	9.6

Table 7. Length distributions of south-west coast herring in 1961

	Spring spawners		Summer spawners		Immature herring	
Gear:	Purse seine	Purse seine	Purse seine	Purse seine	Purse seine	Purse seine
Period:	Jan.–May	Oct.–Dec.	Jan.–May	Oct.–Dec.	Jan.–May	Oct.–Dec.
Length, cm						
41	1	—	—	—	—	—
40	7	—	3	—	—	—
39	22	3	2	—	—	—
38	56	9	17	1	—	—
37	67	20	35	4	—	—
36	58	37	37	17	—	—
35	59	40	70	29	—	—
34	92	83	97	101	—	—
33	115	214	138	208	—	3
32	211	203	262	232	—	3
31	171	152	182	133	—	3
30	91	80	101	109	—	3
29	38	80	33	90	19	24
28	8	51	9	51	75	58
27	3	14	4	17	113	110
26	—	11	2	5	302	176
25	—	—	7	2	415	215
24	—	3	1	1	38	141
23	1	—	—	—	38	82
22	—	—	—	—	—	86
21	—	—	—	—	—	58
20	—	—	—	—	—	31
19	—	—	—	—	—	7
Total	1000	1000	1000	1000	1000	1000
Number of fish	861	350	919	916	53	291
Mean	32.35	31.92	32.40	31.63	25.72	24.75

Table 8. Age distributions of south-west coast herring in 1961 (‰)

Number of winter rings	Spring spawners Jan.–May	Spring spawners Oct.–Dec.	Summer spawners Jan.–May	Summer spawners Oct.–Dec.	Immature herring Jan.–May	Immature herring Oct.–Dec.
1	—	—	—	—	—	179
2	—	3	3	19	19	526
3	10	160	13	197	887	268
4	105	233	94	189	94	24
5	412	369	365	313	—	3
6	121	109	282	186	—	—
7	59	46	57	55	—	—
8	55	26	47	14	—	—
9	19	6	42	13	—	—
10	37	17	38	5	—	—
11	69	23	28	5	—	—
12	68	8	21	3	—	—
13	5	—	5	—	—	—
14	8	—	8	—	—	—
15	11	—	4	—	—	—
16	15	—	1	1	—	—
17	6			—		—
Total	1000	1000	1000	1000	1000	1000
Number of fish	861	350	919	916	53	291
Mean	6.8	5.0	6.2	4.8	3.1	2.3

Table 9. Average length (cm) of age-groups (winter rings)

Age	Spring spawners Jan.–May	Spring spawners Oct.–Dec.	Summer spawners Jan.–May	Summer spawners Oct.–Dec.	Immature herring Jan.–May	Immature herring Oct.–Dec.
1 ...	—	—	—	—	—	21.60
2 ...	—	24.00	—	27.18	24.00	24.76
3 ...	28.22	28.79	27.00	29.86	24.66	26.33
4 ...	30.16	31.17	30.01	30.80	25.00	28.12
5 ...	31.67	32.35	31.46	32.38	—	—
6 ...	32.45	33.00	32.29	32.88	—	32.00
7 ...	33.78	34.31	33.46	33.56	—	—
8 ...	34.79	34.89	34.46	34.38	—	—
9 ...	35.19	35.50	35.07	35.42	—	—
10 ...	36.03	35.67	35.61	36.00	—	—
11 ...	36.85	36.87	35.69	36.00	—	—
12 ...	37.31	37.00	36.84	35.33	—	—
13 ...	37.25	—	36.40			—
14 ...	38.14	—	38.00	—	—	—
15 ...	37.70	—	37.50			
16 ...	38.15	—	39.00	36.00	—	—

Table 6 shows the average amount of *Calanus* per cm² in the herring stomachs. Comparing this survey with corresponding ones in previous contributions (e.g. FRIÐRIKSSON, Ann. Biol., **16** and **17**), it is clear that the feeding conditions of the north and east coast herring in 1961 were much better than in any previous year since 1944. This is in good agreement with the results of former and recent shoaling behaviour studies which strongly suggest that the *Calanus* concentrations are positively correlated with the size but negatively correlated with the swimming speed of the herring shoals during the summer feeding migrations. Thus the increased *Calanus* quantity in 1961 very likely resulted in a much higher level of accessibility than in previous years.

(b) *South-west coast*

The material collected comprised 37 samples. Twenty of them (1,900 fish) were taken during the winter/spring season (January/May), and 17 (1,560 fish) during the autumn season (October/December). As shown in Figure 3, the samples were all from the south-west coast fishing grounds and are therefore not divided geographically in this report.

Table 7 shows the length distributions of the samples, divided into spring spawners, summer spawners and immature herring. It is a striking feature of these data that the modal length of both spawning communities was constant at 32 cm throughout the year. It should also be noted that the mean length of both spring and summer spawners was higher during the spring than during the autumn season. The spawning communities were represented in similar numbers during the spring season, but Table 7 shows that the summer spawners greatly outnumbered the spring spawners during the autumn season.

The age distributions of the tribes are shown in Table 8. Throughout the year, 5-ringers predominated in both spawning communities. Table 8 also shows that the young year-classes (less than 5 rings) were better represented during the autumn than during the spring season. As compared with the corresponding tribes in the north coast samples the old year-classes were very poorly represented in the south-west coast catches, especially during the autumn season.

Table 9 shows the average length for each age-group (defined according to number of winter rings). These data show very clearly the effect of summer growth of each age-group. Comparison of the mean lengths of the spawning communities at the same age reveals that for all age-groups the summer spawners were smaller than the spring spawners in practically all age-groups where the means are based on sufficient numbers. This seems hardly plausible, unless the majority of the Icelandic summer spawners formed their first ring during their first year of life, as some authors have believed. Accordingly it was the 1956 year-class which dominated in the summer, as well as in the spring spawning populations. As already discussed, this year-class was also unusually abundant in the north and east coast catches.

Table 10. Returns of tagged herring in 1961

(*A*) *Returns from north and east coast factories*

	North coast	East coast	South-west coast	Norway
1950	—	—	—	1
1951	1	—	—	3
1952	1	—	—	4
1953	4	—	—	3
1954	16	—	—	5
1955	15	2	2	15
1956	14	6	—	10
1957	22	19	16	14
1958	7	70	—	13
1959	80	—	18	12
1960	54	98	9	10
1961	25	53	87	—
Total	239	248	132	90

(*B*) *Returns from south-west coast factories*

	North coast	East coast	South-west coast	Norway
1954	2	—	—	—
1955	—	—	—	—
1956	2	—	—	—
1957	1	1	—	—
1958	1	5	—	—
1959	41	—	28	—
1960	46	38	5	—
1961	—	2	59	—
Total	93	46	192	—

(c) *Tagging*

Table 10 gives the numbers of internal tags returned from reduction plants in all parts of Iceland in 1961. These data clearly show that the Norwegian and the Icelandic herrings were intermixed in the north and east coast catches in 1961. It should be noted that of the 132 south-west coast tags returned from the north and east coasts, 87 were tagged only two months prior to the fishing season. Probably owing to very few herring tagged in Norway during the winter and spring season of 1960/1961, no comparative returns were received from Norway. Table 10 shows that excluding the 1961 experiments, the returns of Norwegian tags (90) were twice as many as those from the south-west coast (45). During the previous season (1960), on the other hand, south-west coast returns outnumbered Norwegian ones. This change further supports the change shown in Table 4, and discussed in section 2 (a). The total number of returned tags at the north and east coast (709) exceeds by far any previous season. Considering, on the other hand, the number of tags per 100,000 hl reduced in the plants, it appears that there was a total of 39.7 tags, including 5.4 tags from Norway in 1961. Comparison with previous years (Friðriksson, Ann. Biol., **16** and **17**), reveals that the total returns are of similar level but the Norwegian returns are at least twice as high as in any former year. A survey of the four tagging experiments carried out in Icelandic waters in 1961 is given in Table 11.

Table 11. Tagging experiments in 1961

Month	Area	Number of tagged herring
January	South-west coast	1,940
April–May	South-west coast	9,750
July–August	North and east coast	9,450
	Total	21,140

J. Jakobsson

Investigations around Iceland in 1961

In order to locate the Icelandic summer spawning herring approaching the south-west coast of Iceland, a survey was undertaken from 22. May to 2. June with R. V. "Johan Hjort" on the west and north coasts of Iceland. Only small schools of herring were observed near the Vestmanna Islands.

The herring investigations in the Icelandic area were continued with R. V. "G. O. Sars" on a cruise from 5. June to 8. July. After two weeks of asdic survey, collection of hydrographic data and zooplankton on the north and east coast of Iceland, a meeting with the Icelandic research vessel "Ægir" was held in Seydisfjördur on 17. and 18. June. A report from the meeting was presented to the Herring Committee at the ICES meeting in 1961. In the second half of June the work was continued, mainly on the north coast of Iceland. Reports on herring were sent twice daily to the Norwegian fishing fleet. The first catch by the Norwegian purse seiners was taken on 13. June east of Langanes.

The main fishing was later on concentrated north and north-east of Kolbeinsøya. By the end of June and the beginning of July good catches were taken north of Melrakka. A survey on the east coast of Iceland during the first week of July showed that in this area the herring were still scattered, and no schools fit for purse seiners were observed. There were, however, good concentrations of *Calanus* and, one week later, most of the Norwegian fishing fleet moved to that area where good catches of herring were taken.

During the cruise, 5 samples totalling 932 herring were secured from the fishery on the north coast of Iceland. The 1950 year-class was predominant (41%) and the mean length of the samples was 36.3 cm.

On 2. July 1100 herring were tagged (1000 with internal and 100 with Lea hydrostatic tags) and released in position 67°04′N, 15°47′W.

The total yield of the Norwegian summer fishery in the Icelandic area was about 1,106,000 hl of which 958,000 hl were taken by purse seiners and landed at reduction plants in Norway. About 148,000 hl, mainly taken by drifters, were salted on board ship.

OLE J. ØSTVEDT

The Norwegian Winter Herring Fisheries in 1961

(Tables 12–15)

The forecast for the Norwegian winter herring fisheries for the 1961 season was very bad. The herring had been located in December 1960, further west and north in the Norwegian Sea than in any other year, which meant late arrival of the herring to the Norwegian coast. It was also known that all the year-classes supporting the mature stock with recruit spawners were poor, and our calculations indicated a reduction of the mature stock of 25 to 30% from the 1960 level. Because of the more northerly location of the fishing areas in recent years, it was also likely that the main fishing area would be north of Stad, a coastal area which during the herring season is exposed to more severe weather conditions than those further south.

During the first half of January the research ships "G. O. Sars" and "Johan Hjort" were used for mapping the hydrographical conditions in the part of the Norwegian Sea where the herring were supposed to pass on the spawning migration to the Norwegian coast. This work was completed on 18. January, and herring schools located by use of asdic were found to be about 60 miles south of the position they occupied in the middle of December. "Johan Hjort" then returned home for cod investigations, and "G. O. Sars" followed the herring schools for the last 350 miles of the migration. As usual the fishermen were informed, daily, about the approach of the herring. The herring schools followed the "Polar Front" as far as possible in an easterly direction, and passed into Atlantic water east of Møre, and we supposed the schools would continue in an easterly direction. However, off the continental shelf the herring schools turned NE, and followed the isotherms to the Norwegian coast off Kristiansund instead of off Ålesund, where the migrating schools in recent years have dispersed for spawning. The migrating schools passed at unusually deep levels. Only very few schools were located above 150 m depth until they arrived at the continental shelf. During the last 50 miles of the migration, schools could also be located close to the surface. In earlier years the schools have generally followed the southern front of the arctic water until they go through it into the Atlantic water, 100 to 200 miles off the Norwegian coast. When still in

Table 12. Length composition of Norwegian winter herring (‰) A: Stages IV–VIII; B: Total (including stages I–III)

	A		B	
Length, cm	Purse seine	Drift-net	Purse seine	Drift-net
30.0	1	—	1	—
.5	—	1	—	1
31.0	2	3	4	3
.5	—	2	—	2
32.0	1	5	1	5
.5	7	10	7	10
33.0	51	36	51	36
.5	87	65	87	65
34.0	168	165	168	165
.5	191	172	190	174
35.0	191	191	190	191
.5	87	114	87	113
36.0	105	112	105	112
.5	37	55	37	54
37.0	41	42	41	42
.5	16	17	16	17
38.0	10	9	10	9
.5	5	1	5	1
39.0	—	—	—	—
Total	1000	1000	1000	1000
Number sampled ..	808	2,449	809	2,453

Table 13. Age composition of Norwegian winter herring; maturity stages IV–VII (‰)

		Purse seine			Drift-net		
Year-class	Age	N type	S type	Total	N type	S type	Total
1957 ...	4	—	11	4	—	9	4
1956 ...	5	—	23	9	1	27	11
1955 ...	6	—	83	33	—	76	30
1954 ...	7	8	60	29	5	58	26
1953 ...	8	80	72	77	90	93	91
1952 ...	9	18	94	48	17	114	55
1951 ...	10	52	83	65	52	105	72
1950 ...	11	693	434	590	607	416	587
1949 ...	12	35	57	44	26	30	28
1948 ...	13	32	26	30	38	20	31
1947 ...	14	25	19	23	32	20	27
1946 ...	15	20	8	15	11	12	11
1945 ...	16	10	19	14	9	9	9
1944 ...	17	8	11	9	6	5	6
1943 ...	18	5	—	3	8	1	6
1942 ...	19	8	—	4	4	4	4
1941 ...	20	2	—	1	2	—	1
1940 ...	21	2	—	1	1	1	—
1939 ...	22	2	—	1	—	—	—
1938 ...	23	—	—	—	1	—	—
Total		1000	1000	1000	1000	1000	1000
Number sampled		401	265	666	1,195	765	1,960

Scales not fit for age determination = 142.

Table 14. Distribution of spawning groups of Norwegian winter herring (‰)

Spawning groups	Purse seine	Drift-net
I	12	13
II	38	35
III	111	100
IV	155	185
V	165	152
VI	99	129
VII	198	177
VIII	131	130
IX	24	26
X	17	17
XI	14	12
XII	10	10
XIII	12	7
XIV	9	2
XV	2	2
XVI	—	1
XVII	3	1
XVIII	—	1
Total	1000	1000
Number sampled	586	1,721

Table 15. Maturity and racial characters

A. Percentage maturity (all age-groups)

	Maturity stages						
	III	IV	V	VI	VII	VIII	No.
February	0.1	2.4	85.3	10.4	1.6	0.1	805
	—	12.9	82.4	2.5	1.9	0.2	905
March	—	—	11.0	58.9	30.2	—	474
	—	0.2	23.1	42.5	34.2	—	442

B. Vert. S.

	Number of vertebrae					
	55	56	57	58	59	Mean
February	1	22	79	46	1	57.16
March	—	24	142	74	1	57.22

arctic water the schools were located very deep down during the day, down to 500 m depth. In the evening the schools approached the surface, and kept to the surface layer during the night, and in the morning the schools dived down again. After breaking through the front the schools continued their easterly course in the Atlantic water and kept day and night to the layer above 100 m.

The winter herring season lasted from 15. February to 14. April, 47 fishing days in all. The total catch decreased from 3,220,000 hl in 1960 to only 742,388 hl in 1961, 278,426 hl being taken by purse seine and 463,962 hl by drift-net (including set-net).

The season was the poorest since 1902. The number of purse seiners was reduced from 439 in 1960 to only 254 in 1961 and the drifters from 1,110 to 789.

During the season, 30 samples, totalling 3,262 herring were examined. The length and age distributions in the samples are shown in Tables 12 and 13. The mean lengths for the purse seine and drift-net samples were 34.8 and 34.9 cm respectively with a mean age of 10.6 years. The 1950 year-class still predominated and made up 59% of the samples, nearly the same as in 1960 (60%).

The distribution of spawning groups is shown in Table 14. Recruitment to the spawning stock has been very small since the 1950 year-class was fully recruited in 1958. In 1961 I-group spawners only constituted about 1% of the samples, and even the XI-group was more abundant than it.

The maturity and racial characters in February and March are shown in Table 15. It is apparent that less herring in maturity stage IV have been available to the fishing fleet than in the preceding seasons. This must be ascribed to the late arrival of the herring to the spawning grounds. The main spawning took place in March whereas in earlier years more than 50% of the samples consisted of herring in stages VI and VII during the second part of February.

FINN DEVOLD, O. J. ØSTVEDT

Norwegian Tagging Experiments in 1961

(Tables 16–17)

The tagging localities and the number of each category tagged are listed in Table 16. As the land-seine fishery for winter herring failed, it was necessary to secure live fish from the purse seiners. Due to very bad weather during the winter herring season, only 400 large herring were tagged. Of these, 300 were tagged with an internal tag to which a nylon gut was fastened. The gut, which had a length of 2.5 cm, ended externally through the incision of the body wall, where the tag was inserted.

Also in 1961 small herring taggings were successful, and both the 0-and I-groups were tagged at different localities off the Norwegian coast. The fat herring taggings were carried out 20—25 n. miles off the North Cape.

The amount of herring caught by the Norwegian fishing fleet off Iceland for oil- and meal processing in 1961 was 958,874 hl, compared with 645,132 hl in 1960, 328,574 hl in 1959 and 220,322 hl in 1958. A comparison of the recaptures from this fishery with those from the Norwegian winter herring fishery is shown in Table 17. In 1961 a total of 235 internal tags were received from the different factories, 24 during the winter herring season and 211 during the herring season off Iceland. The

Table 16. Taggings in 1961

Area	Date	Category	Number of liberations	by type of tag
Grip (W of Kristiansund)	22.–23. Feb.	Large herring	400	100 internal 300 internal with gut
67°04′N 15°47′W (North Iceland)	2. July	North coast herring	1,100	1000 internal 100 external
20 n.m. N of North Cape	12. Sept.	Fat herring	1,450	950 internal
25 n.m. N of Nordkyn	22. Sept.	Fat herring		500 internal
Varangerfjord	20. Sept.	I-group		200 internal
Torsken (Senja)	6. Sept.	0-group		1000 internal
Varangerfjord	20. Sept.	0-group		1000 internal
Torsvåg (N of Tromsö)	25. Sept.	0-group		2000 internal
Hekkingen (S of Tromsö)	27. Sept.	0-group		500 internal

Table 17. Number of returns in 1958, 1959, 1960 and 1961 from the different experiments

Year of tagging	Category	Number tagged	Recaptures from: The Norwegian winter herring season				The north and east coast herring season off Iceland			
			1958	1959	1960	1961	1958	1959	1960	1961
1948	NH	7,475	—	1	—	—	1	—	—	
1951	NH	3,064	1	2	1	—	2	3	—	1
1952	NH	17,308	12	16	5	—	8	6	11	—
1953	NH	10,181	10	9	9	—	7	8	10	4
1954	NH	8,783	11	11	3	—	22	22	6	7
1955	NH	9,241	15	23	4	1	32	18	11	8
1956	NH	8,443	23	17	14	—	48	30	20	10
1957	NH	7,550	21	23	13	1	39	38	18	14
1958	NH	9,594	—	22	21	4	—	40	47	27
1959	NH	9,946	—	—	34	1	—	—	63	41
1960	NH	11,135	—	—	—	—	—	—	—	38
		Total	93	124	104	7	159	165	186	150
1948	SH	6,018	1	1	—	—	—	—	—	—
1949	SH	8,261	1	4	—	—	1	1	—	—
1950	LH	9,085	1	5	2	—	—	—	—	—
1950	SH	11,215	—	4	1	—	—	1	—	1
1951	LH	5,998	1	5	1	—	—	—	1	1
1951	SH	9,986	3	9	2	—	2	—	—	4
1952	LH	10,295	2	1	3	—	—	1	—	—
1952	SH	10,863	20	34	8	1	1	2	2	1
1952	FH	7,971	4	3	2	—	—	—	1	3
1953	LH	10,080	—	1	1	—	2	—	—	—
1953	SH	10,046	3	9	4	—	—	1	1	—
1953	FH	8,496	—	1	5	—	—	—	—	—
1954	LH	10,042	4	5	2	—	—	1	2	2
1954	SH	10,291	12	24	13	—	2	—	—	5
1954	FH	14,970	5	5	3	—	—	—	—	1
1955	LH	10,045	19	16	8	2	1	1	5	1
1955	SH	9,087	4	6	4	—	—	—	—	1
1955	FH	13,586	13	16	4	—	—	—	4	2
1956	LH	4,998	4	7	10	—	—	1	1	2
1956	FH	12,799	9	24	9	—	—	—	1	3
1957	LH	9,500	16	16	21	—	—	2	2	2
1957	SH	8,450	16	16	18	2	—	1	—	1
1957	FH	3,900	6	4	2	1	1	—	—	1
1958	SH	9,998	—	62	22	2	—	2	1	4
1958	FH	6,200	—	6	11	—	—	—	1	2
1959	SH	13,950	—	—	16	3	—	—	5	4
1959	FH	8,100	—	—	17	3	—	—	1	7
1960	LH	2,449	—	—	—	3	—	—	—	8
1960	SH	1,500	—	—	—	—	—	—	—	5
		Total	144	284	189	17	10	14	28	61

NH = North and east coast herring. SH = Spring herring. LH = Large herring. FH = Fat herring and 'torlangstsild'.

within season recoveries, and tags received from factories which do not possess magnets, have not been taken in consideration. Out of 24 recovered tags during the winter herring season, 17 were released as spring and large herring, 'forfangstsild' and fat herring; 7 were tagged as north coast herring.

The composition of the recaptures off Iceland this summer shows the same general pattern as the previous year (Table 17), although there was a slight increase of N-tags (herring tagged off the Norwegian coast) in relation to I-tags (herring tagged off Iceland). This increase must be due to a greater influx of Norwegian spring spawners, especially of the 1950 year-class.

A quantitative comparison of I-tags recaptured during the Norwegian winter herring season in 1961 with those recovered in the previous seasons could not be undertaken, since the amount of herring for oil- and meal processing was to small.

OLAV DRAGESUND

Results of Soviet Investigations on Atlanto-Scandian Herring in 1961

In 1961 the herring fishing conditions in the Norwegian Sea differed from those in 1960 in a number of striking respects. One important feature was a considerable delay in the arrival of the spawning stock on the main spawning grounds off the Norwegian coast. In 1960 this delay was evident, but in 1961 it increased still more. Compared with an average date of 22. January, based on a large number of earlier years the fishery for pre-spawning herring off the Norwegian coast in 1960 started on 7. February, while in 1961, it did not begin until 12. February. Thus, in 1961 the herring approached the coast over three weeks later.

At the same time there was a shift of the spawning grounds to more northerly areas off the west coast of Norway. The most extensive spawning of herring on the Norwegian Shallows in 1960 took place on the Griptarene Bank, while in 1961 it was northwards, within the limits of the Freja Bank and mainly on the Halten and Sklinna Banks.

In the period from 9. February to 25. March 1961, two significant arrivals of herring were observed in the Freja Bank area and two still more numerous ones were observed on Halten and Sklinna Banks. The arrival in the Freja Bank area was the most favourable one for the fishery, which lasted from 19. to 23. February. For the fishery as a whole the average catch per drift-net in this period was over 175 kg. All other arrivals took place under extremely unfavourable conditions. Therefore, we can only judge their strengths from the efficiency of spawning, estimated on the basis of catches of herring larvae hatched on every bank of the Norwegian Shallows.

In spite of the delay in the arrival of the pre-spawning shoals in the Norwegian Shallows in 1961, the mass spawning differed little from the average long-term data for these spawning grounds. According to larval data the relative efficiency of the spawning on the main spawning grounds of the Norwegian Shallows in 1961 was less than half the 1960 level. For instance, in the Griptarene Bank area, which had been the main spawning ground up to 1960, the average number of larvae per sample decreased more than 7 times. But, on the northern banks where the most intensive spawning took place in 1961, the number of larvae also decreased by about half compared with that in 1960.

Another peculiar feature of the 1961 season was the complete absence of pre-spawning and spawning herring in the Lofoten Shallows. With the more westerly and northerly distribution of the concentrations of pre-spawning herring in the East Icelandic Current in October/December 1960 the possibility of the arrival of herring in the Lofoten Shallows seemed to be greater than in 1960.

In 1960 the total catch by the Soviet fishing fleet of the pre-spawning and spawning herring in the Lofoten Shallows amounted to over 12,000 tons. In 1958 arrivals of herring in that area were still more intensive and longer. That year the herring fishery was rather efficient till the end of the first ten-day period of April.

Unfortunately, in 1961, for the first time during the past four years the USSR did not take part in the joint survey in the Norwegian Sea in June by research vessels of Norway, Denmark and Iceland. Such a survey, carried out by Soviet ships over the period from 8. to 28. June could not cover the coastal waters of Iceland and polar areas north of Iceland. But in previous years that area was examined in detail by Icelandic and Danish scientists.

As a result of this survey, a small decrease of the total heat content in the upper 0—50 m layer for the whole southern part of the Norwegian Sea was revealed. However, it was found that the heat content in the same layer in the central and northern parts of the sea was somewhat above the long-term average and for 1960 along all the branches of the Norwegian Current. At the same time, the production of planktonic food was about the same as in 1960. In the areas with mixed and cold waters of the East Icelandic Current it was somewhat delayed.

The distribution of isotherms at 20 m, in the south-western part of the Norwegian Sea, testifies to the continuing decrease of the East Icelandic Current. Therefore a marked shifting of its limits was recorded in northern and western directions. Such a shifting allowed the adult herring of Norwegian origin to enter the coastal waters, along the north coast of Iceland.

The areas along the polar front from Jan Mayen to Mohn's Threshold were surveyed by scouting vessels from the end of June till the end of August. A marked movement of herring in this direction for feeding was recorded only at the beginning of August. The herring concentrations there were unsteady and the productivity of the fishery was only half as large as that in the areas off the north coast of Iceland.

In mid-September, in the area off the north coast of Iceland the summer Icelandic and spring Norwegian herring were observed to begin their mass movement offshore. This movement was in an easterly direction, to the western boundary of the East Icelandic Current. The productivity of the drift-net fishery, both during the period of feeding in Icelandic waters in August, and during the period of offshore movement in September was rather low, averaging about 25 kg per drift-net.

It is worth noting that from the end of March to the end of July 1961, the Soviet fishery in the Norwegian Sea ceased, due to the low fat content of the herring after spawning. Therefore the maximum concentrations of herring off the north coast of Iceland in July were not exploited.

In October the fat herring, leaving polar waters bordering upon the north-east coast of Iceland were observed. However, they did not form large concentrations. Fishing for these herring along the western edge of the East Icelandic Current did not raise the total yield of the fishery. The average catch per drift-net in October was less than half the 1960 value and less than a third of that in 1959.

In the second half of October the formation of pre-spawning concentrations of spring spawners took place in the south-western part of the cold-water wedge of the East Icelandic Current. This region was gradually replenished by concentrations moving from the south and north-west. As a result, the major part of the adult herring stock was concentrated, at the end of the month, in a small area, which gave rise to an increase in the productivity of the fishery.

Echo-surveys in mid-December 1961 of the whole wintering area showed that herring concentrations were distributed over an area not exceeding 150 square miles. The total volume and density was less than half the 1959 level. The small extent and volume of the herring concentrations during the autumn/winter period of 1961 resulted in irregular catches by drift-nets.

While fishing in the south-western areas of the Norwegian Sea, especially during the period from August to December, a considerable amount of small herring, 17—25 cm long, belonging to the 1959 year-class, evaluated numerically as above average, was observed. In August and September, the by-catch of these herring in nets of 30—32 mm mesh size, made up between 5% and 10%.

It is likely that, in these areas the main bulk of these herring came from the spring spawning grounds located around the Faroes and partly from the summer spawning grounds off the south-east coast of Iceland. But in 1962, the majority of this year-class, originating from Norwegian, inshore waters, will move to the open regions of the Norwegian Sea and constitute the main object of the fishery in its eastern part.

The commercial stock composition shows that the general state of the herring resources in the Norwegian Sea in 1961 was less satisfactory than that in the four preceding years. A further falling off in the fishing conditions will take place due to further reduction of the migration pattern and the fishing area. As the rate of the spawning migrations during the two last years has been noticeably disturbed in comparison with the previous years, considerable deviations of the rate of feeding migrations after spawning are also possible, which can also adversely affect the results of the fishery.

I. G. Yudanov

B. Near Northern Seas

Young Stages

Scottish Adolescent Herring Fisheries

(Tables 18–21)

A. North Sea

The catch and effort statistics for the "halflin" fisheries in the Firth of Forth and the upper Moray Firth, during the season 1960—61, are given in Table 18. In both areas the total catch and the catch per arrival were the lowest that have been recorded for a considerable number of years. Landings from the Firth of Forth were so small that no samples from this fishery were obtained; in the Moray Firth one-ringed fish made up 90% of the landings, and otolith analysis showed 99% of the catch to be of autumn-spawned origin.

The size range, mean length, and mean Vert. S. of the one-ringed autumn-spawned fish from the Moray Firth are given in Table 19. These are in close agreement with similar figures published for previous years.

B. Clyde

The catch and effort statistics for the Clyde ring-net fishery for adolescent herring in the 1961 season are given in Table 20. The catch and catch per landing both show a slight drop in comparison with the 1960 season.

The autumn spawning component in the fishery was rather greater than normal, making up 12% of the total landings. As regards the spring spawning component, the strong 1958 year-class again proved the mainstay of the fishery. Age analysis gave the following contributions of the year-classes to the season's catch, 1960 year-class 23%, 1959 year-class 28%, 1958 year-class 43%, 1957 year-class 6%.

The mean lengths and meristic data of the major age-groups of the spring and autumn spawning components, as separated by otolith analysis, are given in Table 21.

ALAN SAVILLE

Table 18. Statistics of "halflin" fisheries 1956–61

	Season				
	1956–57	1957–58	1958–59	1959–60	1960–61
			Upper Moray Firth		
Duration of season	6/10/56–9/2/57	14/9/57–22/2/58	11/10/58–7/2/59	31/10/59–12/3/60	22/10/60–28/1/61
Number of landings	2,274	891	710	1,186	169
Total catch (crans)	34,605	5,715	5,407	18,056	658
Catch/landing (crans)	15.2	6.4	7.6	15.2	3.9
			Upper Firth of Forth		
Duration of season	8/9/56–16/3/57	21/9/57–19/4/58	10/11/58–21/3/59	28/11/59–9/4/60	28/1/61–11/3/61
Greatest number of boats engaged	16	22	16	13	6
Estimated catch of "halflins" (crans)	328	3,352	1,310	6,417	195
Estimated catch of "halflins" per arrival (crans)	6.31	7.56	6.45	12.99	2.1

Table 19. Length and mean Vert. S. of I-group herring in inshore waters off Scottish east coast in 1960–61

Locality	Date	Length range (cm)	Mean (cm)	Mean Vert. S.
		Autumn 1958 year-class		
Upper Moray Firth (drift-net)	October 1960	18–22	20.41 (45)	56.60 (45)
	November 1960	17–22	19.91 (121)	56.53 (118)

Table 20. Statistics of Clyde adolescent fishery 1956–61

	Season					
	1956	1957	1958	1959	1960	1961
Number of landings	1,482	3,132	3,186	3,958	5,778	4,319
Total catch (crans)	29,844	20,481	28,550	60,289	72,943	49,015
Catch/landing (crans)	20.1	6.5	9.0	15.2	12.6	11.3

Table 21. Length and meristic data of I, II and III-group herring in Clyde adolescent fishery in 1960/61

Rings		Length	Vert. S.	K_2	Pectoral fin
1	Spring spawned	19.98 (569)	56.86 (257)	14.47 (198)	16.95 (264)
	Autumn spawned	20.44 (31)	56.64 (11)	14.00 (12)	17.08 (12)
2	Spring spawned	23.25 (558)	56.71 (275)	14.57 (213)	17.29 (276)
	Autumn spawned	23.49 (160)	56.65 (71)	14.49 (53)	17.40 (72)
3	Spring spawned	25.13 (964)	56.98 (516)	14.42 (382)	16.96 (513)
	Autumn spawned	25.63 (95)	56.58 (43)	14.43 (42)	16.86 (42)

The German Oil Herring Fishery in 1961

(Tables 22–23)

The continuation of the German oil herring investigations at the Institut für Küsten- und Binnenfischerei in 1961 gave the following results.

(1) The total catch amounting to 20,473 tons, had a similar size as in 1960 (22,391 tons). The price per kg of the oil herring recovered slightly, but was average, at 0.099 DM, only 0.01 DM higher than 1960.

(2) The fishing season started in full at the beginning of July and terminated as usual in October. The fishing grounds were also as usual: Southern Schlickbank, Clay Deep, Coffee Soil, Tail End, Lower Scruff, Upper Scruff.

(3) The length compositions of 18 samples are given in Table 22. In July and August the dominant length groups were 21 cm, 22 cm and 23 cm. The herring were therefore older than in the preceding year, when the peak of the length distribution was between 17 and 19 cm (Meyer-Waarden, Ann. Biol., **17**: 174—75). The herring in both years belonged to the 1958 year-class. Herring of the 1959 year-class were only rarely represented (K. Tiews: C.M. 1961, Doc. No. 27) found already that the absence of the 1959 year-class off the German coast during the winter 1960/61, had caused a complete failure of the German winter fishery for juvenile herring. This is also in agreement with the investigations of Hempel, who found catches of herring larvae of the 1959 year-class in the southern North Sea and English Channel at the beginning of 1960 to be extremely poor (Tiews, loc. cit.).

In September the herring of the 1959 year-class disappeared from the catches. Instead, small herring, with a dominant modal length between 13 and 15 cm, were caught in the same fishing area. This sudden change of catch composition has a parallel in 1957. As Kühl (Arch. Fischereiwiss., **8**: 182—97, 1957) reports, the August catches of that year included also such small herrings between 13 and 15 cm, which were born in the preceding year (1956 year-class) and had a growth-rate above average. Also the September herring of 1961 belonged to a well grown population of fish, belonging to the 1960 year-class only.

Table 22. Length distributions (‰) of oil herring in 1961

Month	July	August	September	Total
Number of samples	3	5	10	18
Locality	Southern Schlickbank, Clay Deep	Clay Deep, Tail End, Dogger Bank	Clay Deep, Tail End	
Depth, m	40–55	30–70	40–57	
Length, cm				
10	—	—	4	3
11	—	—	24	16
12	—	—	62	43
13	—	—	196	134
14	—	—	424	290
15	—	—	236	161
16	—	—	42	29
17	—	—	3	2
18	4	5	1	2
19	78	16	1	13
20	112	84	1	31
21	272	141	1	62
22	209	272	1	79
23	155	230	2	65
24	116	131	—	40
25	50	58	2	19
26	4	47	—	9
27	—	8	—	1
28	—	3	—	0
29	—	5	—	1
30	—	—	—	—
n	258	382	1,381	2,021

(4) Eighteen unsorted samples amounting to 5,232 fish (181 kg) were investigated as to their species and size composition. The following catch composition, by species and weight proportions was found:—

Species	%
Herring	52.4
Sprat	22.6
Whiting	21.8
Bastard mackerel	1.7
Mackerel	0.6
Dab	0.3
Gurnard	0.2
Others	0.4

As in 1960 (Meyer-Waarden, loc. cit.) the proportion of whiting was very high, with the very

Table 23. Length distributions (‰) of whiting contained in the oil herring catch in 1961

Month	July	August	September	Total	(1960, for comparison)
Number of samples	3	5	10	18	6
Locality	Southern Schlickbank, Clay Deep	Clay Deep, Tail End, Dogger Bank	Clay Deep, Tail End		
Depth, m	40–55	30–70	40–57		
Length, cm					
7	—	—	3	3	—
8	—	—	5	4	—
9	—	—	23	21	—
10	—	24	46	44	9
11	—	24	58	54	14
12	—	120	110	108	4
13	—	47	146	137	14
14	—	—	89	81	9
15	—	—	76	69	9
16	—	—	30	27	5
17	—	—	5	4	9
18	—	—	5	4	32
19	—	24	3	4	126
20	67	167	18	29	239
21	133	47	25	29	153
22	—	262	33	48	77
23	333	72	39	48	81
24	266	47	48	53	50
25	67	24	48	48	54
26	67	47	48	48	58
27	—	47	53	51	18
28	67	—	26	26	9
29	—	24	23	23	9
30	—	—	15	14	4
31	—	—	10	9	4
32	—	24	8	9	9
33	—	—	2	1	4
34	—	—	3	3	—
35	—	—	2	1	—
n	15	42	607	664	222

rich 1959 year-class dominating. In September the rich 1961 year-class also appeared. This also seems to be of above average numerical strength. The size compositions of whiting for both years, 1960 and 1961, are given in Table 23. Haddock by-catches were not observed in the catch samples.

(5) 3.5% of the catches consisted of undersized protected fish: 3.3% of these were whiting, mostly of the 1961 year-class and 0.2% were dab. Thus the by-catches of undersized protected fish were of similar magnitude to the previous year.

P. F. Meyer-Waarden

The Winter Catches of Juvenile Herring in German Coastal Waters, their Fluctuations and the Possibilities of their Prediction

(Tables 24–25)

The investigations on the availability of juvenile herring in German coastal waters were continued in 1961 at the Institut für Küsten- und Binnenfischerei (see also Tiews, 1961 a, b, c; 1962). The main emphasis of this year's study was placed on the question whether the strong fluctuation of catch can be predicted. As Table 24 shows, the catches fluctuate considerably. In the years covered, the largest annual yield of juvenile herring ever obtained, amounting to nearly 3,000 metric tons, was taken in 1926. In recent years the largest quantity, 2,771 tons, was caught in the 1951/52 season. Thereafter the catch decreased to only 6 tons in 1956/57, and increased again to 1,473 tons in 1959/60. This increase is coincident with the systematic introduction of trawl nets into the fishery. In the most recent seasons, 1960/61 and 1961/62, despite numerous fishing trials, practically no herring were caught as juveniles on the usual fishing grounds, and consequently the winter fishery became a complete failure (Tiews, 1961c).

There are obviously strong year-to-year fluctuations in the availability of juvenile herring along the German coast during the winter months, but,

Table 24. Catches (in tons) of adult and juvenile herring and of sprat in Ostfriesland and Oldenburg in the years 1921–61

(Based on statistics of the "Staatliche Fischereiamt Bremerhaven")

Year	Adult herring	Juvenile herring	Sprat	Total
1921	121	521	—	642
2	151	1,238	—	1,389
3	68	585	—	653
4	48	649	—	697
5	30	1,009	—	1,039
6	170	2,631	—	2,801
7	326	2,920	—	3,246
8	184	2,615	—	2,799
9	69	449	—	518
1930	51	452	—	503
1	85	1,361	—	1,446
2	95	1,327	—	1,422
3	35	879	5	919
4	96	418	60	574
5	57	1,273	—	1,330
6	32	342	—	374
7	12	464	—	476
8	6	309	—	315
9	1	111	—	112
1940	1	248	—	249
1	0	1,649	—	1,649
2	0	1,258	—	1,258
3	—	1,550	—	1,550
4	—	885	—	885
5	—	606	—	606
6	—	3	—	3
7	—	710	223	933
8	—	1,694	717	2,411
9	—	1,473	75	1,548
1950	—	1,750	80	1,830
1950/51 ...	—	1,449	22	1,471
1951/52 ...	—	2,771	7	2,778
1952/53 ...	—	1,105	—	1,105
1953/54 ...	—	495	17	512
1954/55 ...	1	119	108	228
1955/56 ...	1	93	194	288
1956/57 ...	—	6	76	82
1957/58 ...	41	220	118	379
1958/59 ...	21	632	100	753
1959/60 ...	96	1,473	58	1,627
1960/61 ...	13	5	11	29
1961/62 ...	1	0	5	6

unfortunately, little is known of their causes and whether it is possible to predict the success of a forthcoming fishing season. It is the aim of this paper to disseminate some new knowledge on this question, gained during recent years when scientific investigations were carried out by the Institut für Küsten- und Binnenfischerei, and which may deserve special attention with regard to an early recognition of fluctuations in the recruitment of the North Sea herring stock.

According to these investigations, a prediction of the winter catch of juvenile herring is possible shortly before the start of the season; it was found that poor or good catches during the winter coincide with those made by German shrimp fishermen in the same area during the preceding summer and autumn. This was concluded from research material collected by the above-mentioned Institute on the catch compositions of the German shrimp fishery since 1954 (Meyer-Waarden, 1959, 1960; Tiews, 1961 d). This research, originally initiated to assess the quantity of protected and unprotected fish in the German shrimp catch, has in the meanwhile led to new knowledge of considerable importance concerning the fluctuations in abundance of the first year-classes of many species of fish in the coastal waters of the German Bight. From 1954 to 1961, 4,345 random samples of unsorted shrimp catches each of 5 kg were investigated as to their species and length composition. Samples from known localities and total catch were taken between one and three times a week, at 11—12 shore stations during the research period 1954 to 1956, and at 5—7 stations since 1957. The shore stations were: Wyk/Föhr, Husum, Tönning, Büsum, Friedrichskoog, Cuxhaven, Fedderwardersiel, Varel, Wilhelmshaven, Neuharlingersiel, Norddeich, and Greetsiel.

On the basis of these investigations, and of the official catch statistics, the amount of herring caught by the shrimp fishery, was calculated. There are always juvenile herring present in the coastal waters, but the fish appear in larger quantities on the shrimp fishing grounds at the beginning of August. The herring are then some 6—8 cm in length, and they were found to be much more abundant off the coast of Niedersachsen than of Schleswig-Holstein. For comparison of summer and winter catches of juvenile herring (Table 25) the following sets of data are given: (1) total number of juvenile herring caught in the shrimp fishery off the coast of Niedersachsen, (2) number of juvenile herring caught in the shrimp fishery in terms of catch per net and 10 hrs, (3) total yield of the winter fishery for juvenile herring, and (4) catch per trip during the winter fishery.

According to these data, during the period 1957/1959, both summer and winter catches of juvenile herring were much higher than during the preceding years and the succeeding years of 1960 and 1961. Catches were highest in 1959, when 5,566 herring were caught per 10 hrs with one shrimp net and the catch per trip amounted to 1,785 kg in the winter fishery. From 1959 to 1960, the summer and winter catches both show a sharp decline. During the summer of 1960, 186 specimens only were caught, and catches of the winter fishery were zero. Similar poor results were obtained in 1961. Looking at the

Table 25. Comparison of catches of juvenile herring caught in the shrimp fishery and the winter fishery on the coast of Niedersachsen

	1954	1955	1956	1957	1958	1959	1960	1961
Total no. of juvenile herring caught in the shrimp fishery (mill. fish)	6	11	17	141	144	206	13	16
Number per net and 10 hrs	120	207	345	3,120	3,156	5,566	186	255
Total yield of winter fishery for juvenile herring (tons)	119*	93*	6	220	632	1,473	5	0
Catch per trip	+)	+)	+)	634	988	1,785	0	0
	(1954/55)	(55/56)	(56/57)	(57/58)	(58/59)	(59/60)	(60/61)	(61/62)

*) These catches may have been mixed with sprat to a large extent and have to be interpreted with caution.
+) Data not available.

total yields of the winter fishery during the period 1957 to 1959, it must be kept in mind that the number of boats participating in the fishery increased from 32 (1957/58) to 50 (1958/59), and then to 78 (1959/60) (TIEWS, 1961 b).

It can be seen from Table 25 that good and poor summer catches coincide with good and poor winter catches. So, having known the poor summer catches of 1961, the poor result of the winter fishery of juvenile herring off the coast of Niedersachsen could be predicted (Institut für Küsten- und Binnenfischerei, 1961). The fishermen were thus able to limit their usual fishing trials to a minimum.

Apart from this interesting correlation between the summer and winter catches of juvenile herring in German coastal waters, it seems likely that, to a certain degree, another correlation exists, namely between the catch of herring larvae in the eastern English Channel and the southern North Sea and that of juvenile herring on the coast of Niedersachsen. From German research on the distribution and abundance of herring larvae in the areas of the Dogger Bank, southern North Sea and English Channel as part of the international cooperation in this field, it can be concluded that the catch of herring larvae was about ten times higher early in 1959 than in 1960. From this, it can be concluded that the numerical strength of the 1959 year-class of herring must be considered a very poor one, compared with the 1958 year-class. Consequently, it is not surprising that the catch of juvenile herring was alsmost zero in the German coastal waters during the winter of 1960/61. On the other hand, the high catches of juvenile herring during the summer of 1959 and the winter of 1959/60 may allow the conclusion that the herring of the 1958 year-class must have been of a very high numerical strength. This conclusion is confirmed by the latest results of the investigations of the German oil herring fishery. MEYER-WAARDEN (see page 154) stated that the 1958 year-class made up the greater part of the oil herring catch in 1960 and 1961, while the 1959 year-class was found in the catches of fishing season 1960 to a rather small proportion only, although fish of this age usually contribute the main proportion of the oil herring catch.

The larval catch of the 1960 year-class was again more numerous than the 1959 year-class. However, it was found to be much less abundant than the 1958 year-class, which was three times as abundant as the 1960 year-class. Although being more abundant than the 1959 year-class, the summer catch of juvenile herring of the 1960 year-class in 1961 was nearly as poor as that of the 1959 year-class has been in German coastal waters. Correspondingly the winter fishery in 1961/62 did not produce any catch despite numerous fishing trials.

This phenomenon may be explained as follows: It has been found that the 1960 year-class has had a growth-rate above average. So the fish of this year-class occurred during September 1961 one year earlier than usual in the German oil herring catch in the eastern Dogger Bank area and made its main contribution to the fishery, then having an average length of 13—15 cm (MEYER-WAARDEN, this volume, p. 154). In normal years this length is being reached during the following winter.

The 1960 year-class can be compared with the 1956 year-class, which also had an abnormal high growth-rate and in 1957 also recruited the oil herring fishery one year earlier than usual. It is likely that these fast growing fish have overlept one year's development and behave differently from normal year-classes. They may differ from the normal fish in having also different distribution areas, which are outside the reach of the coastal fisheries. In other words, the catching rates of juvenile herring in German coastal waters do not have, necessarily, to be correlated with the absolute abundance of the respective year-classes. Such a correlation may only exist if the fish has developed normally.

The latest results of German larval investigations indicate, according to unpublished data of HEMPEL that the 1961 year-class has been found even three times more abundant than the rich 1958 year-class so that, if its development is normal, a rich occurrence of juvenile herring in the German coastal waters during the coming winter may be expected. However, a prediction can only first be made after the summer distribution of juvenile herring in this area has been studied.

K. TIEWS

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Adult, Commercial Fish

Scottish Fisheries, 1961

A. North Sea

(Figures 5–7; Tables 26–36)

The Fisheries

Drift-net

During 1961 drift-net fishing was carried out from the following Scottish ports: Aberdeen (April to mid-September), Fraserburgh (May to September), Peterhead (mid-May to mid-September), and Lerwick (May to mid-August).

The catch and effort statistics for all ports combined are given in Table 26, by area and month. The effort statistics do not refer to the number of arrivals at port, as in previous years but to the number of hauls made.

The feature of the fishery in 1961 was the scarcity of herring on the traditional Buchan grounds (south of 59°N) in May/July. In these months most of the catches in the north-western North Sea came from grounds off Shetland, Fair Isle and Orkney. In August, however, the fishing became concentrated on the Buchan grounds, within 40 to 50 miles of the coast.

The total catch for the season was much less than in 1960 but the catch per haul was 25.5 crans in 1961 compared with 20.0 crans in 1960.

Table 26. Drift-net landings, Scotland (east coast), 1961

	Apr.	May	June	July	Aug.	Sept.
North-eastern North Sea, east of 2°E						
Catch in crans	1,187	2,076	—	—	48	—
No. of hauls	72	69	—	—	3	—
Average catch per haul	16.5	30.1	—	—	16.0	—
North-western North Sea, north of 59°N						
Catch in crans	227	11,787	39,646	25,460	926	—
No. of hauls	24	481	1,145	1,042	111	—
Average catch per haul	9.0	24.5	34.6	24.4	8.3	—
North-western North Sea, south of 59°N						
Catch in crans	—	196	3,222	5,000	30,136	1,059
No. of hauls	—	66	107	212	1,351	59
Average catch per haul	—	3.0	30.1	23.5	22.3	17.9

Trawl

Herring trawlers, mainly Swedish and Danish, made landings at Aberdeen from the north-eastern North Sea, Shetland (within 50 miles of Lerwick), the Fladen Ground, and from the Gut southwards.

Table 27. Trawled herring landings, Scotland, 1961

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
North-eastern North Sea												
Catch in crans	224	2,039	2,214	—	155	—	342	—	601	1,522	114	—
Hours fishing	8	214	220	—	102	—	70	—	116	536	32	—
Crans per 100 hours ...	2,800	953	1,006	—	152	—	489	—	518	284	356	—
Shetland waters												
Catch in crans	—	—	—	—	52	—	—	533	—	—	—	—
Hours fishing	—	—	—	—	40	—	—	148	—	—	—	
Crans per 100 hours ...	—	—	—	—	130	—	—	360	—			
Fladen Ground												
Catch in crans	—	—	—	98	229	276	3,599	3,348	2,611	757	—	—
Hours fishing	—	—	—	88	157	135	1,055	1,298	732	190	—	—
Crans per 100 hours ...	—	—	—	111	146	204	341	258	356	398	—	—
The Gut												
Catch in crans	—	—	—	—	—	—	—	78	208	1,731	—	—
Hours fishing	—	—	—	—	—	—	—	50	71	617	—	—
Crans per 100 hours ...	—	—	—	—	—	—	—	156	293	280	—	—

Their catch and effort statistics are given in Table 27, according to area and month. Landings in which herring made up less than 50% of the total catch have not been included.

The total landings in 1961 were slightly greater than in 1960 but the catches per unit effort in the north-eastern North Sea and on the Fladen Ground were almost double those of 1960. The catches per unit effort from the Gut were almost the same in 1961 as in 1960.

Biological Data

Drift-net

The sampling of the drift-net fishery was carried out as in previous years. The data, however, have been grouped according to area of fishing and not according to port of landing.

North-eastern North Sea (grounds east of 2°E)

The length and age compositions of the samples are shown in Figure 5: the maturity, Vert. S., K_2, and pectoral fin data are given in Table 28, and the age compositions of the spring and autumn spawners (separated on otolith characters) are given in Table 29.

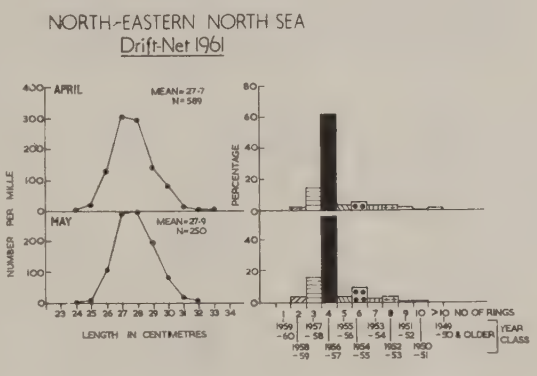

Figure 5. Length and age composition of north-eastern North Sea drift-net samples April and May 1961 (length frequencies unsmoothed).

Table 28. Maturity and racial characters, north-eastern North Sea, drift-net 1961

A. Percentage Maturity (All age-groups)

	Maturity Stage I	II	III	IV	V	VI	VII	VII-II	No.
April	2.2	15.5	—	—	—	0.9	31.1	50.4	589
May	2.8	16.4	—	—	—	—	20.4	60.4	250

B. Vert. S. (Actual numbers – All age-groups)

	Number of Vertebrae 54	55	56	57	58	59	Mean	No.
April	—	9	118	148	12	1	56.57	288
May	—	4	18	22	3	—	56.51	47

C. K_2 (Actual Numbers – All age-groups)

	Number of Keeled Scales 12	13	14	15	16	17	Mean	No.
April	4	67	123	71	6	—	14.03	271
May	1	4	22	22	1	—	14.36	50

D. Pectoral Fins (Actual numbers – All age-groups)

	Number of Fin Rays 15	16	17	18	19	20	Mean	No
April	3	32	114	115	20	—	17.41	284
May	—	4	24	15	6	—	17.46	49

Table 29. Age composition of spring and autumn spawners, north-eastern North Sea, April/May 1961

Spring group				Autumn group				Total sample			
Year-class	Winter rings	Number April	Number May	Year-class	Winter rings	Number April	Number May	Number Spring	Number Autumn	% Spring	% Autumn
1959	2	4	5	1958	2	6	5	9	11	45.0	55.0
1958	3	8	3	1957	3	77	39	11	116	8.7	91.3
1957	4	2	1	1956	4	363	140	3	503	0.6	99.4
1956	5	—	—	1955	5	22	11	—	33	—	100.0
1955	6	—	—	1954	6	35	26	—	61	—	100.0
1954	7	—	—	1953	7	22	7	—	29	—	100.0
1953	8	—	—	1952	8	24	10	—	34	—	100.0
1952	9	—	—	1951	9	11	1	—	12	—	100.0
1951	10	—	—	1950	10	2	1	—	3	—	100.0
1950 and older ...	>10	—	—	1949 and older ...	>10	6	—	—	6	—	100.0
Totals		14	9	Totals		568	240	23	808	2.8	97.2

These data show that spring spawned herring made an even smaller contribution to the sampled stocks than in 1960 (Ann. Biol., **17**). The 1956 year-class (4-ringers) was again dominant amongst the autumn spawners; it contributed 62% of the total samples. The 1957 year-class, which was poorly represented in 1960, contributed 14% of the total.

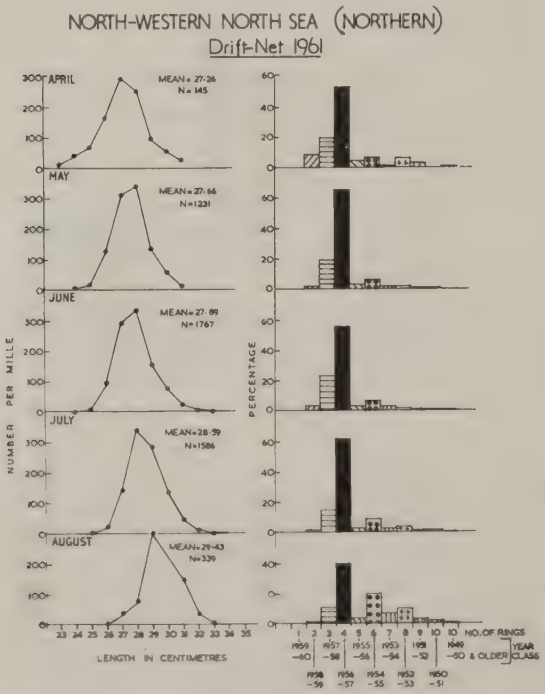

Figure 6. Length and age composition of north-western North Sea (north of 59°N) drift-net samples April to August 1961 (length frequencies unsmoothed).

North-western North Sea
(grounds west of 2°E and north of 56°N)

The samples from this area have been grouped into those taken north of 59°N and those taken south of 59°N.

Samples from north of 59°N. The length and age compositions of these samples are shown in Figure 6: the maturity, Vert. S., K_2, and pectoral fin data are given in Table 30, and the age compositions of the spring and autumn spawners (separated on otolith characters) are given in Table 31.

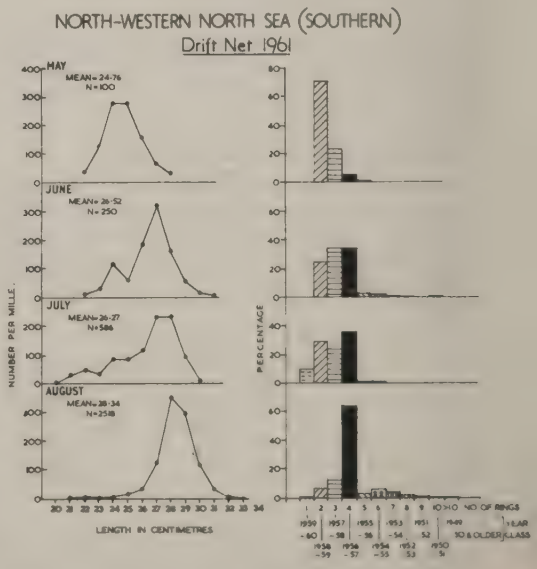

Figure 7. Length and age composition of north-western North Sea (south of 59°N) drift-net samples May to August 1961 (length frequencies unsmoothed).

Table 30. Maturity and racial characters, north-western North Sea, north of 59°N, drift-net 1961

A. Percentage Maturity (All age-groups)

Maturity Stage

	I	II	III	IV	V	VI	VII	VII-II	No.
April	6.2	2.8	—	—	—	—	**49.0**	**42.1**	145
May	0.9	**47.0**	0.7	0.1	—	—	11.9	**39.5**	1,231
June	1.4	**77.5**	14.7	4.0	0.2	—	0.5	1.7	1,767
July	0.4	15.2	**30.6**	**32.7**	14.8	3.6	1.5	1.2	1,586
August ..	0.9	4.1	0.6	26.5	**48.1**	11.8	7.4	0.6	339

B. Vert. S. (Actual numbers – All age-groups)

Number of Vertebrae

	54	55	56	57	58	59	60	Mean	No.
April					No data				
May	—	14	132	130	13	1	1	56.51	291
June	—	12	149	156	23	—	—	56.56	340
July	2	18	151	179	20	—	—	56.53	370
August ..		1	31	57	6	—	—	56.71	95

C. K_2 (Actual numbers – All age-groups)

Number of Keeled Scales

	12	13	14	15	16	17	18	Mean	No.
May	2	33	116	91	24	1	—	14.39	267
June	1	36	138	111	30	2	—	14.44	318
July	3	57	156	110	17	—	—	14.24	343
August ..	—	11	41	24	11	1	—	14.43	88

D. Pectoral Fins (Actual numbers – All age-groups)

Number of Fin Rays

	15	16	17	18	19	20	Mean	No.
May	3	31	123	110	19	—	17.39	286
June	5	44	142	120	19	3	17.34	333
July	1	36	150	155	24	3	17.47	369
August ..	—	14	49	29	3	—	17.22	95

Table 31. Age composition of spring and autumn spawners, north-western North Sea, north of 59°N, April/August 1961

Spring group

Year-class	Winter rings	Number April	May	June	July	Aug.
1960 ..	1	—	—	—	—	—
1959 ..	2	4	8	35	13	2
1958 ..	3	2	21	22	24	6
1957 ..	4	—	9	19	36	7
1956 ..	5	—	—	3	8	—
1955 ..	6	—	—	2	9	2
1954 ..	7	—	—	—	1	—
1953 ..	8	—	—	—	1	—
1952 ..	9	—	—	—	1	—
1951 ..	10	—	—	—	—	—
1950 and older	>10	—	—	—	—	—
Totals		6	38	81	93	17

Autumn group

Year-class	Winter rings	Number April	May	June	July	Aug.
1959 ..	1	—	—	—	1	—
1958 ..	2	8	19	30	42	1
1957 ..	3	25	205	379	201	30
1956 ..	4	75	777	961	944	126
1955 ..	5	6	39	58	56	14
1954 ..	6	9	71	122	126	66
1953 ..	7	2	24	45	49	25
1952 ..	8	8	27	43	56	34
1951 ..	9	4	9	15	14	10
1950 ..	10	—	4	4	8	7
1949 and older	>10	2	3	5	7	4
Totals		139	1,178	1,662	1,504	317

Total sample

Number Spr.	Aut.	% Spr.	Aut.
—	1	—	100.0
62	100	38.3	61.7
75	840	8.2	91.8
71	2,883	2.4	97.6
11	173	6.0	94.0
13	394	3.2	96.8
1	145	0.7	99.3
1	168	0.6	99.4
1	52	1.9	98.1
—	23	—	100.0
—	21	—	100.0
235	4,800	4.7	95.3

Table 32. Maturity and racial characters, north-western North Sea, south of 59°N, drift-net 1961

A. Percentage Maturity (All age-groups)

Maturity Stage

	I	II	III	IV	V	VI	VII	VII-II	No.
May	21.0	**76.0**	—	—			—	3.0	100
June	5.6	**82.8**	7.6	1.2				2.8	250
July	9.9	16.9	21.3	**31.6**	17.6	2.6		0.2	586
August ..	1.0	1.5	1.3	10.4	26.1	**34.6**	23.8	1.3	2,518

B. Vert. S. (Actual numbers – All age-groups)

Number of Vertebrae

	54	55	56	57	58	59	60	Mean	No.
May	—	8	39	48	3			56.47	98
June		1	18	27	3			56.55	49
July	1	20	107	109	12	1	—	56.46	250
August ..	1	35	241	277	30	—	—	56.51	584

C. K_2 (Actual numbers - All age-groups)

Number of Keeled Scales

	12	13	14	15	16	17	18	Mean	No.
May	1	12	37	28	8	3		14.43	89
June	—	1	16	23	10	—		14.84	50
July	2	31	112	73	29	2	1	14.42	250
August ..	3	55	268	205	49	3		14.43	583

D. Pectoral Fins (Actual numbers – All age-groups)

Number of Fin Rays

	15	16	17	18	19	20	Mean	No.
May	2	13	48	29	5		17.23	97
June	1	12	21	10	5		17.12	49
July	3	39	135	65	14	1	17.20	257
August ..	6	79	248	218	36	1	17.34	588

Table 33. Age composition of spring and autumn spawners, north-western North Sea, south of 59 N, May August 1961

Spring group						Autumn group						Total sample			
Year-class	Winter rings	Number May	June	July	Aug.	Year-class	Winter rings	Number May	June	July	Aug.	Number Spring	Autumn	% Spring	Autumn
1960 ..	1	—	—	—	—	1959 ..	1	—	—	50	19	—	69	—	100.0
1959 ..	2	1	4	3	12	1958 ..	2	69	53	93	137	20	352	5.4	94.6
1958 ..	3	3	2	—	7	1957 ..	3	20	78	95	283	12	476	2.5	97.5
1957 ..	4	1	—	—	1	1956 ..	4	4	81	172	1,594	2	1,851	0.1	99.9
1956 ..	5	—	—	—	1	1955 ..	5	1	6	5	72	1	84	1.2	98.8
1955 ..	6	—	—	—	1	1954 ..	6	—	7	4	146	1	157	0.6	99.4
1954 ..	7	—	—	—	—	1953 ..	7	—	2	—	89	—	91	—	100.0
1953 ..	8	—	—	—	—	1952 ..	8	—	2	—	52	—	54	—	100.0
1952 ..	9	—	—	—	—	1951 ...	9	—	—	—	13	—	13	—	100.0
1951 ..	10	—	—	—	—	1950 ..	10	—	1	—	8	—	9	—	100.0
1950 and older > 10		—	—	—	—	1949 and older > 10		—	—	—	4	—	4	—	100.0
Totals		5	6	3	22	Totals		94	230	419	2,471	36	3,160	1.1	98.9

Table 35. Age and length compositions of trawled herring, 1961

A. Per Mille Length Composition

Month	Stat. Square	Length (cm) 20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	Mean	No.
Jan. ...	15H	—	—	—	20.0	20.0	80.0	200.0	260.0	120.0	120.0	120.0	40.0	20.0	—	—	27.48	50
Febr. ..	17G	—	—	—	20.0	60.0	160.0	320.0	120.0	180.0	60.0	40.0	20.0	20.0	—	—	26.70	50
	15H	20.0	—	80.0	40.0	80.0	180.0	260.0	260.0	40.0	20.0	20.0	—	—	—	—	25.58	50
March ..	17H	—	—	—	—	—	—	80.0	140.0	220.0	220.0	200.0	80.0	60.0	—	—	28.80	50
	16H	—	—	—	—	20.0	80.0	260.0	220.0	200.0	120.0	80.0	20.0	—	—	—	27.28	50
June ...	15E	—	—	—	54.3	97.8	173.9	163.0	282.6	152.2	54.3	10.9	10.9	—	—	—	26.32	92
July ...	18D	—	—	—	—	—	—	20.0	120.0	320.0	240.0	140.0	100.0	60.0	—	—	28.90	50
	17E	—	—	—	—	—	—	—	90.9	454.5	303.0	101.0	30.3	20.2	—	—	28.59	99
	15E	—	—	—	—	4.5	—	22.5	144.1	342.3	288.3	121.6	49.5	27.0	—	—	28.58	222
	10D	—	—	—	120.0	120.0	240.0	160.0	260.0	100.0	—	—	—	—	—	—	25.62	50
August .	17A	—	—	—	—	—	—	—	122.4	367.3	285.7	142.9	81.6	—	—	—	28.64	49
	17F	—	—	—	—	—	—	20.0	20.0	200.0	180.0	420.0	140.0	20.0	—	—	29.46	50
	16E	—	—	—	—	—	101.0	202.0	909.0	282.8	232.3	212.1	141.4	101.0	—	—	28.96	99
	15C	—	—	—	—	—	—	20.0	60.0	560.0	280.0	60.0	10.0	—	—	—	28.36	50
	13C	—	—	—	—	—	—	—	220.0	260.0	400.0	120.0	—	—	—	—	28.42	50
	13D	—	—	—	—	—	20.0	80.0	200.0	200.0	340.0	160.0	—	—	—	—	28.24	50
	13F	—	—	—	—	—	—	40.8	122.4	306.1	214.2	204.1	112.2	—	—	—	28.76	98
	12D	—	—	—	—	—	—	—	102.0	408.2	306.1	132.7	51.0	—	—	—	28.62	98
Sept. ...	18E	—	—	—	—	—	—	20.0	100.0	400.0	320.0	120.0	40.0	—	—	—	28.54	50
	17E	—	—	—	—	—	—	10.0	100.0	320.0	370.0	130.0	70.0	—	—	—	28.72	100
	17F	—	—	—	—	—	—	—	160.0	320.0	240.0	220.0	40.0	—	10.0	—	28.74	50
	17G	—	—	—	—	—	—	20.0	360.0	400.0	160.0	20.0	40.0	—	—	—	27.92	50
	16D	—	—	—	—	—	—	20.0	140.0	480.0	300.0	40.0	20.0	—	—	—	28.23	50
	16E	—	—	—	—	—	—	40.0	160.0	480.0	160.0	140.0	—	20.0	—	—	28.28	50
	15D	—	—	—	—	—	—	61.2	224.5	346.9	204.1	122.4	40.8	—	—	—	28.27	49
	15E	—	4.0	—	—	—	4.0	36.0	200.0	444.0	216.0	72.0	16.0	8.0	—	—	28.13	250
	13F	—	—	—	—	—	60.0	160.0	260.0	280.0	160.0	40.0	40.0	—	—	—	28.00	50
	11E	—	—	—	—	—	—	—	160.0	200.0	280.0	220.0	100.0	20.0	20.0	—	29.04	50
Oct.	17H	—	—	—	—	—	20.0	40.0	140.0	500.0	240.0	60.0	—	—	—	—	28.08	50
	16H	—	—	—	—	—	—	20.0	100.0	420.0	240.0	180.0	20.0	—	20.0	—	28.62	50
	15G	—	—	—	—	—	—	80.0	260.0	320.0	200.0	80.0	40.0	20.0	—	—	28.14	50
	15H	—	—	—	—	—	—	20.0	40.0	160.0	200.0	280.0	180.0	60.0	40.0	20.0	29.78	50
	14C	—	—	—	—	—	—	40.0	140.0	500.0	200.0	120.0	—	—	—	—	28.22	50
	14F	—	—	—	—	—	80.0	60.0	280.0	260.0	220.0	100.0	—	—	—	—	27.78	50
	13F	—	—	—	—	—	20.0	50.0	140.0	320.0	250.0	150.0	40.0	30.0	—	—	28.40	100
	13G	—	—	—	—	20.0	—	160.0	200.0	320.0	120.0	100.0	80.0	—	—	—	27.96	50
Nov. ...	16H	—	—	—	—	—	20.0	40.0	100.0	320.0	260.0	180.0	80.0	—	—	—	28.62	50

Table 35. (continued)
B. Percentage Age Composition

Month	Stat. Square	Number of Winter Rings 1	2	3	4	5	6	7	8	9	10	>10	Number
January	15H	—	2.04	10.20	**61.22**	—	12.24	2.04	8.16	2.04	—	2.04	49
February	17G	—	6.00	14.00	**64.00**	—	6.00	2.00	4.00	2.00	—	2.00	50
	15H	—	20.00	28.00	**46.00**	—	4.00	—	—	2.00	—	—	50
March	17H	—	—	10.42	**35.42**	2.08	20.83	10.42	6.25	4.17	8.33	2.08	48
	16H	—	—	20.00	**52.00**	4.00	16.00	—	2.00	6.00	—	—	50
June	15E	—	**42.39**	14.13	**39.13**	2.17	1.09	—	—	—	1.09	—	92
July	18D	—	10.20	14.29	**42.86**	4.08	6.12	10.20	4.08	—	4.08	4.08	49
	17E	—	2.04	19.39	**63.27**	3.06	6.12	4.08	1.02	—	1.02	—	98
	15E	—	3.64	12.73	**54.09**	7.23	9.09	5.45	2.73	0.91	2.28	1.81	220
	10D	—	**46.00**	20.00	**24.00**	6.00	2.00	—	—	—	2.00	—	50
August	17A	—	10.20	6.12	**55.10**	2.04	6.12	8.16	10.20	2.04	—	—	49
	17F	—	6.00	20.00	**42.00**	—	12.00	12.00	6.00	—	—	2.00	50
	16E	—	12.12	6.06	**49.49**	8.08	5.05	6.06	12.12	—	1.01	—	99
	15C	—	8.00	18.00	**62.00**	4.00	4.00	2.00	2.00	—	—	—	50
	13C	—	6.00	12.00	**72.00**	2.00	6.00	2.00	—	—	—	—	50
	13D	—	18.37	10.20	**48.99**	2.04	8.16	4.08	6.12	2.04	—	—	49
	13F	—	5.10	11.22	**47.96**	7.14	11.22	7.14	5.10	5.10	—	—	98
	12D	—	3.09	17.53	**59.80**	3.09	8.25	4.12	3.09	—	1.03	—	97
September	18E	—	4.08	12.24	**67.35**	2.04	6.12	2.04	2.04	2.04	2.04	—	49
	17E	—	4.04	13.13	**61.61**	7.07	5.05	4.04	3.03	2.02	—	—	99
	17F	—	8.16	14.29	**48.98**	8.16	4.08	2.04	4.08	10.20	—	—	49
	17G	—	10.00	34.00	**42.00**	—	10.00	2.00	2.00	—	—	—	50
	16D	—	2.00	4.00	**76.00**	4.00	4.00	6.00	4.00	—	—	—	50
	16E	—	2.00	16.00	**66.00**	6.00	10.00	—	—	—	—	—	50
	15D	—	4.08	16.33	**61.22**	—	4.08	6.12	2.04	4.08	2.04	—	49
	15E	—	3.56	15.56	**64.89**	2.22	6.22	2.67	3.11	0.89	0.44	0.44	225
	13F	—	20.00	26.00	**36.00**	—	6.00	2.00	6.00	4.00	—	—	50
	11E	—	2.00	14.00	**60.00**	6.00	6.00	6.00	4.00	2.00	—	—	50
October	17H	—	6.00	16.00	**68.00**	4.00	—	2.00	2.00	2.00	—	—	50
	16H	—	2.00	8.00	**74.00**	4.00	2.00	4.00	4.00	2.00	—	—	50
	15G	—	—	24.00	**62.00**	2.00	6.00	2.00	2.00	—	—	2.00	50
	15H	—	2.00	4.00	**50.00**	6.00	24.00	12.00	2.00	—	—	—	50
	14C	—	8.00	18.00	**58.00**	4.00	8.00	4.00	—	—	—	—	50
	14F	—	24.49	18.37	**40.81**	4.08	8.16	2.04	2.04	—	—	—	49
	13F	—	9.18	16.33	**57.14**	4.08	6.12	4.08	1.02	2.04	—	—	98
	13G	2.08	16.67	14.58	**41.67**	4.17	2.08	4.17	12.50	2.08	—	—	48
November	16H	—	12.00	14.00	**52.00**	4.00	6.00	8.00	4.00	—	—	—	50

Table 34. Mean lengths (cm) of 2–5-ringed herring, Fraserburgh and Peterhead

Winter rings / Year	2	3	4	5
1950	24.51	24.92	26.05	27.73
1951	24.73	25.76	25.93	26.49
1952	24.86	26.25	26.82	27.26
1953	24.54	26.37	27.00	28.09
1954	24.69	26.92	28.12	28.71
1955	24.18	26.81	28.68	29.34
1956	24.76	26.97	28.36	29.43
1957	24.28	26.16	28.30	29.31
1958	24.51	26.76	28.09	28.97
1959	24.88	26.28	28.25	29.25
1960	24.57	26.14	27.75	28.86
1961	24.96	26.84	28.22	28.96

Spring spawned herring also formed a very small proportion of these samples and the age composition of the autumn spawned herring was very similar to the age composition found in the north-eastern North Sea.

Samples from south of 59°N. The length and age compositions of these samples are shown in Figure 7: the maturity, Vert. S., K_2, and pectoral fin data are given in Table 32, and the age composition of the spring and autumn spawners (separated on otolith characters) are given in Table 33.

The contribution made to these stocks by spring spawned herring was negligible. The age composition of the stock changed markedly as the season progressed. In May the bulk of the stock sampled came from the autumn spawners of the 1958 year-class (2-ringed), while the 1956 year-class (4-ringed), which dominated the stocks north of 59°N was almost absent. As the season advanced the proportion of the 1956 year-class increased, along with an improvement in the fishery, until, in August, the age composition resembled closely the age compositions found in the north-eastern North Sea in April/May and in the northern part of the north-western North Sea in May/July.

Table 36. Maturity and racial characters of trawled herring, 1961

(*A*) *Percentage Maturity* (*All age-groups*) (*B*) *Vert. S.* (*Actual numbers*)

Month	Stat. Square	Maturity Stage I	II	III	IV	V	VI	VII	VII-II	No.	Number of Vertebrae 54	55	56	57	58	59	Mean	No.
Jan. ...	15H	18.00	2.00	4.00	—	—	—	**72.00**	—	50	—	3	20	24	2	1	56.56	50
Febr. ..	17G	**44.00**	6.00	—	—	—	—	8.00	**42.00**	50	—	1	22	22	1	—	56.50	45
	15H	**30.00**	12.00	—	—	—	—	2.00	**56.00**	50	—	1	20	20	6	—	56.66	47
March ..	17H	—	14.00	—	—	—	—	4.00	**82.00**	50	—	4	22	21	1	1	56.45	49
	16H	—	18.00	—	—	—	—	14.00	**68.00**	50	—	—	25	17	5	—	56.57	47
June ...	15E	15.22	**61.96**	9.78	10.87	—	—	—	2.17	92	—	2	18	18	1	—	56.46	39
July ...	18D	4.00	8.00	**36.00**	**34.00**	14.00	—	—	4.00	50	—	6	23	18	2	—	56.33	49
	17E	—	6.06	6.06	**41.41**	**32.32**	12.12	1.01	1.01	99	—	—	—	—	—	—	—	—
	15E	1.35	4.95	28.38	**53.60**	10.81	0.90	—	—	222	1	7	42	40	9	—	56.49	99
	10D	4.00	**44.00**	28.00	16.00	4.00	2.00	—	2.00	50	1	9	13	21	2	—	56.26	46
August .	17A	—	12.24	—	**55.10**	20.41	8.16	—	4.08	49	—	—	—	—	—	—	—	—
	17F	10.00	**34.00**	—	4.00	16.00	2.00	24.00	10.00	50	—	—	—	—	—	—	—	—
	16E	3.03	8.08	4.04	**37.37**	29.29	18.18	—	—	99	—	—	—	—	—	—	—	—
	15C	—	4.00	—	2.00	8.00	10.00	**76.00**	—	50	—	—	—	—	—	—	—	—
	13C	—	2.00	4.00	16.00	28.00	**50.00**	—	—	50	—	2	25	19	3	—	56.47	49
	13D	—	6.00	—	6.00	2.00	28.00	**58.00**	—	50	—	2	14	25	4	—	56.69	45
	13F	—	1.02	—	—	8.16	14.29	**76.53**	—	98	—	3	19	20	2	—	56.48	44
	12D	—	1.02	—	6.12	35.71	**55.10**	1.02	1.02	98	—	2	20	26	1	—	56.53	49
Sept. ...	18E	2.00	—	—	—	—	—	**98.00**	—	50	—	—	—	—	—	—	—	—
	17E	—	8.00	—	—	—	—	**48.00**	**44.00**	50	—	3	20	25	2	—	56.52	50
	17F	2.00	4.00	2.00	—	—	—	36.00	**56.00**	50	—	—	—	—	—	—	—	—
	17G	—	6.00	—	—	—	—	24.00	**70.00**	50	—	5	17	24	3	—	56.10	49
	16D	—	—	4.00	—	4.00	4.00	**76.00**	12.00	50	—	—	—	—	—	—	—	—
	16E	—	2.00	—	—	—	—	**68.00**	30.00	50	—	—	—	—	—		—	—
	15D	2.04	—	2.04	—	2.04	12.24	**73.47**	8.16	49	—	—	—	—	—	—	—	—
	15E	1.20	0.80	—	0.40	0.80	0.80	**76.80**	19.20	250	—	4	39	49	6	—	56.58	98
	13F	—	—	—	2.00	2.00	2.00	**74.00**	20.00	50	—	—	—	—	—	—	—	—
	11E	—	10.00	2.00	2.00	—	—	**60.00**	26.00	50	—	—	—	—	—	—	—	—
Oct.	17H	—	12.00	—	—	—	—	8.00	**80.00**	50	—	—	—	—	—	—	—	—
	16H	—	8.00	—	2.00	—	—	—	**90.00**	50	—	1	21	21	7	—	56.68	50
	15G	—	12.00	—	—	2.00	2.00	22.00	**62.00**	50	—	—	—	—	—	—	—	—
	15H	—	16.00	10.00	—	—	2.00	4.00	**68.00**	50	—	—	—	—	—	—	—	—
	14C	—	14.00	—	—	—	2.00	28.00	**56.00**	50	—	—	23	26	1	—	56.56	50
	14F	—	2.00	—	4.00	—	2.00	20.00	**72.00**	50	—	—	—	—	—	—	—	—
	13F	—	8.00	7.00	2.00	—	—	13.00	**70.00**	100	—	3	19	24	2	—	56.52	48
	13G	2.00	18.00	—	—	—	—	12.00	**68.00**	50	—	—	—	—	—		—	—
Nov. ...	16H	—	14.00	12.00	2.00	—	—	4.00	**68.00**	50	—	—	—	—	—	—	—	—

(*C*) K_2 (*Actual numbers – All age-groups*) (*D*) *Pectoral Fins* (*Actual numbers – All age-groups*)

Month	Stat. Square	Number of Keeled Scales 12	13	14	15	16	17	18	Mean	No.	Number of Fin Rays 15	16	17	18	19	20	Mean	No.
January	15H	2	10	24	12	2	—	—	14.04	50	—	5	22	18	3		17.40	48
February ...	17G	—	11	25	10	1	—	—	14.02	47	—	4	27	17	1		17.31	49
	15H	—	9	26	10	1	1	—	14.13	47	—	14	29	6	—	—	16.84	49
March	17H	—	10	27	13	—	—	—	14.06	50	—	8	24	18	—		17.20	50
	16H	—	6	24	16	4	—	—	14.36	50	—	6	23	16	2	1	17.46	48
June	15E	—	4	18	15	4	—	—	14.46	41	—	7	17	13	3	—	17.30	40
July	18D	—	10	21	15	1	—	—	14.15	47	—	7	24	14	5		17.34	50
	15E	1	15	35	32	9	1	—	14.39	93	2	16	43	29	6		17.22	96
	10D	—	8	20	18	2	—	—	14.29	48	2	14	30	3	1		16.74	50
August	13C	—	2	23	16	7	—	—	14.58	48	2	2	24	17	5		17.42	50
	13D	—	7	17	22	1	2	—	14.47	49	1	10	24	13	2	—	17.10	50
	13F	—	8	24	12	3	—	—	14.21	47	1	6	16	22	3		17.42	48
	12D	—	3	20	22	3	—	1	14.59	49	1	11	23	10	4		17.10	49
September ..	17E	1	7	26	11	1	1	—	14.15	47	—	7	26	13	4		17.28	50
	17G	—	11	24	10	2	—	—	14.06	47	—	14	19	13	4		17.14	50
	15E	2	14	54	24	2	1	—	14.13	97	1	5	37	43	8		17.55	94
October	16H	—	9	29	11	1	—	—	14.08	50	—	5	21	18	6	—	17.50	50
	14C	1	8	26	12	2	—	—	14.12	49	—	5	23	19	1		17.33	48
	13F	—	5	24	13	6	—	—	14.42	48	—	5	19	22	3		17.47	49

The mean lengths of 2—5-ringed herring in the samples from Fraserburgh and Peterhead in 1961 and earlier years are given in Table 34.

Trawl

The data from the samples taken from trawler landings at Aberdeen have been grouped by statistical squares. The length and age compositions are given in Table 35 and the maturity, Vert. S., K_2 and pectoral fin data are shown in Table 36.

The data from all areas show that the 1956—57 year-class (4-ringed), dominated the trawl fisheries as well as the drift-net fisheries over the northern North Sea.

B. West Coast

(Figures 8–9; Tables 37–41)

The Fisheries

Minch

During 1961, drift and ring-net fishing was conducted in the Minch from the following main ports; Stornoway, Ullapool and Gairloch in the North Minch and Mallaig and Oban in the South Minch.

Landing statistics at the North and South Minch ports in 1961 are given by months in Table 37.

These statistics show that although some fishing was in progress throughout the year, the greatest productivity occurred in the winter and late autumn. The total yield and number of arrivals at Minch ports in 1961 was lower than in 1960 (Ann. Biol., **17**). Except for the South Minch drift-net fishery the catch per arrival for 1961 was also lower compared with the previous year.

The major decrease in landings was in the North Minch drift-net fishery, where landings for 1961 were about 40% lower than in the previous year. This reduction in the catch can be largely accounted for by the scarcity of herring on North Minch grounds during the normally very productive late autumn season.

Biological Data

Length and age composition data for North and South Minch samples are given in Figures 8 and 9, and maturities, Vert. S., K_2 and pectoral fin ray data are given in Tables 38 and 39. North Minch data are from drift-net samples and South Minch data are from ring-net samples.

The age distribution data show that the 1957—58 year-class was generally the most abundant one in the samples for most of the year. In the winter and late autumn season, 4-ringed fish of the 1956—57 year-class were also prominent, particularly in the North Minch area.

The 1958—59 year-class, the new recruits to the stock, was relatively small compared with those of 1957—58 and 1956—57, and played an unimportant part in the catches during the late summer and early autumn.

The percentages of spring and autumn spawners in the samples are given in Tables 40 and 41. As in previous years (Ann. Biol., **16** and **17**) the herring on the Minch grounds were composed predominantly of autumn spawning fish. During October/December on the South Minch grounds, spring spawners averaged 25% of the catches, which was relatively higher than in the rest of the year. The majority of these spring spawners were three year-old fish of the 1958 year-class. The results from a tagging experiment in November in the South Minch suggest that at least part of this group are migrants from the Clyde.

Table 37. West coast herring landings, 1961

Month	Landings (crans)				Number of arrivals				Landings per arrival (crans)			
	North Minch		South Minch		North Minch		South Minch		North Minch		South Minch	
	Drift-net	Ring-net	Drift-net	Ring-net	Drift-net	Ring-net	Drift-net	Ring-net	Drift-net	Ring-net	Drift-net	Ring-net
January ...	6,540	6,003	8,042	18,720	319	178	212	392	20.5	33.7	37.9	47.8
February ..	12,788	3,961	6,871	1,607	674	151	184	47	19.0	26.2	37.3	34.2
March	12,987	527	2,576	51	832	30	84	4	15.6	17.6	30.7	12.8
April	1,820	905	118	813	321	97	8	71	5.7	9.3	14.8	11.5
May	223	204	8	3,186	53	61	1	176	4.2	3.3	8.0	18.1
June	2,489	173	—	1,473	172	36	—	123	14.5	4.8	—	12.0
July	7,280	649	21	1,707	517	99	3	123	14.1	6.6	7.0	13.9
August	3,899	816	1,534	4,133	409	81	67	205	9.5	10.1	22.9	20.2
September .	1,287	856	186	3,088	248	72	16	174	5.2	11.9	11.6	17.8
October ...	135	212	—	746	37	42	—	56	3.7	5.1	—	13.3
November .	11,802	1,752	380	8,805	691	116	20	281	17.1	15.1	19.0	31.3
December .	7,744	1,208	2,258	22,772	484	44	80	391	16.0	27.5	28.2	58.2
Total ...	68,994	17,266	21,994	67,200	4,757	1,003	675	2,043	14.5	17.2	32.6	32.9

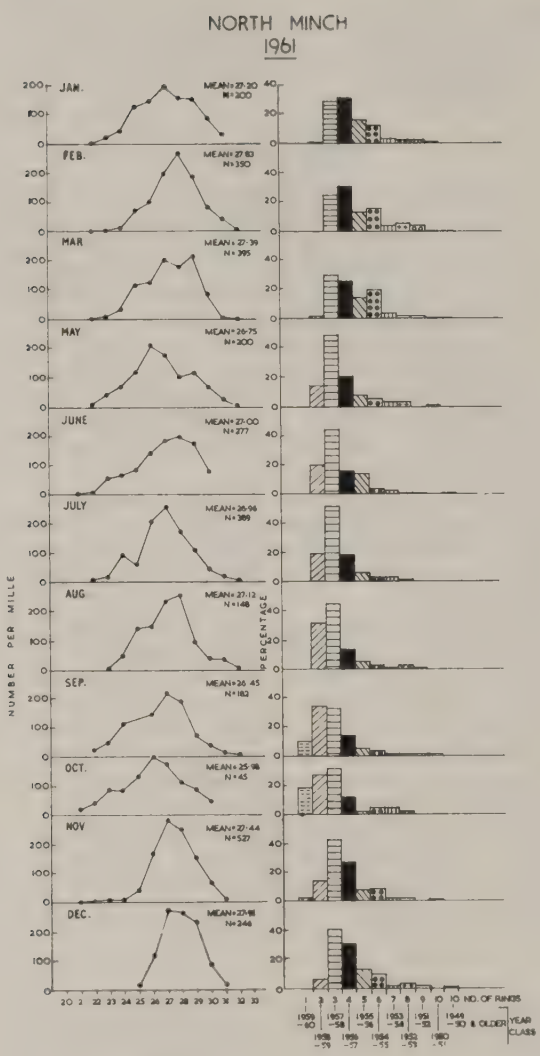

Figure 8. Length and age composition of North Minch drift-net samples January to December 1961 (length frequencies unsmoothed).

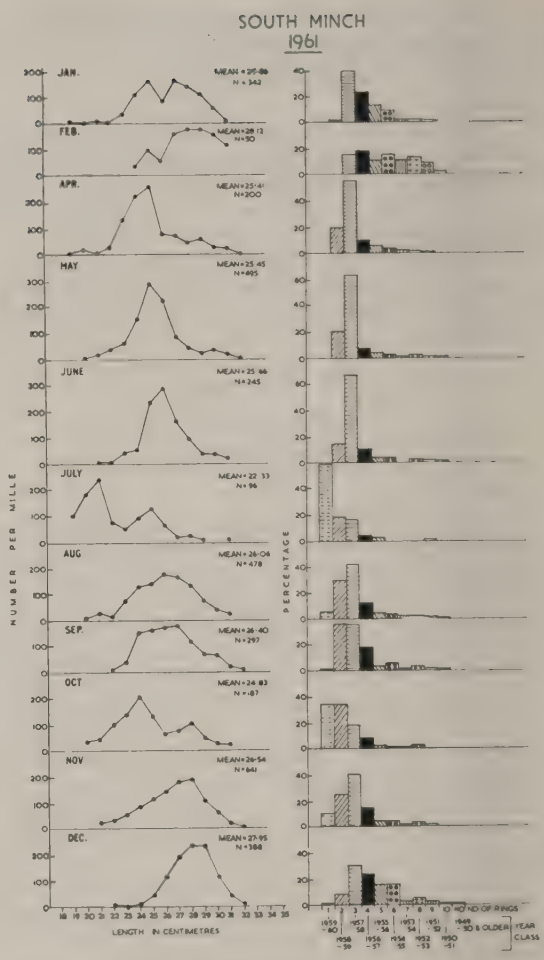

Figure 9. Length and age composition of South Minch ring net samples January to December 1961 (length frequencies unsmoothed).

Table 38. Maturity and racial characters, North Minch 1961

A. Percentage Maturity (All age-groups)

Month	Maturity Stage I	II	III	IV	V	VI	VII	VII-II	No.
January	21.5	1.5	2.5	4.0	0.5	—	0.5	69.5	200
February ...	14.0	11.1	2.9	6.0	4.6	0.3	0.3	60.9	350
March	10.9	23.0	0.5	0.8	0.8	0.3	—	63.8	395
May	17.0	61.0	—	—	—	—	—	22.0	200
June	11.2	63.9	11.9	10.1	0.4	—	—	2.5	277
July	5.7	22.1	40.1	26.0	6.2	—	—	—	389
August	4.7	14.2	10.1	41.2	29.1	—	0.7	—	148
September ..	22.0	4.9	4.4	6.6	2.7	26.9	26.4	6.0	182
October	20.0	11.1	—	—	—	—	—	68.9	45
November ..	6.1	8.5	3.6	4.0	0.4	—	—	77.4	527
December ..	3.7	8.9	1.2	3.3	1.2	1.6	5.7	74.4	246

B. Vert. S. (Actual Numbers – All age-groups)

Month	Number of Vertebrae 54	55	56	57	58	59	Mean	No.
January	—	5	35	48	9	1	56.65	98
February ...	—	3	41	49	7	—	56.60	100
March	—	12	53	71	9	—	56.53	145
May	—	1	44	47	6	—	56.59	98
June	—	1	45	50	2	—	56.54	98
July	—	2	84	101	2	1	56.56	190
August	—	2	20	23	5	—	56.62	50
September ..	—	1	20	22	1	—	56.52	44
October	—	1	19	20	4	—	56.61	44
November ..	—	1	87	101	6	—	56.57	195
December ..	—	4	55	74	12	—	56.65	145

C. K_2 (Actual Numbers – All age-groups)

Month	Number of Keeled Scales 12	13	14	15	16	17	18	19	Mean	No.
January	2	24	48	19	—	—	—	—	13.90	93
February ...	—	20	52	22	4	—	—	—	14.10	98
March	—	21	77	36	4	—	—	—	14.17	138
May	—	18	50	22	2	—	—	—	14.09	92
June	—	25	46	17	1	—	—	—	13.93	89
July	—	27	97	55	8	—	—	—	14.24	187
August	1	5	24	16	3	—	—	—	14.31	49
September ..	—	4	28	10	—	—	—	—	14.14	42
October	—	10	21	10	2	—	—	—	14.09	43
November ..	—	33	102	48	11	1	—	—	14.21	195
December ..	2	20	83	34	6	—	—	—	14.15	145

D. Pectoral Fins (Actual Numbers – All age-groups)

Month	Number of Fin Rays 14	15	16	17	18	19	20	Mean	No.
January	—	—	16	34	37	8	—	17.39	95
February ...	—	—	14	45	37	3	1	17.32	100
March	—	1	27	62	46	8	—	17.23	144
May	—	—	12	50	24	9	—	17.32	95
June	—	—	8	53	28	5	1	17.35	95
July	—	1	23	84	68	13	—	17.37	189
August	—	2	4	21	17	5	—	17.39	49
September ..	—	—	6	20	15	3	—	17.34	44
October	—	—	2	23	15	3	—	17.44	43
November ..	—	—	23	88	73	10	2	17.39	196
December ..	1	2	15	65	48	13	—	17.36	144

Table 39. Maturity and racial characters, South Minch 1961

A. Percentage Maturity (All age-groups)

Month	Maturity Stage I	II	III	IV	V	VI	VII	VII-II	No.
January	18.4	14.9	4.1	0.9	0.6	—	—	61.1	342
February ...	6.0	4.0	—	2.0	—	—	—	88.0	50
April	35.0	7.5	—	—	—	—	1.0	56.5	200
May	37.4	21.8	—	—	—	—	2.4	38.4	495
June	25.7	64.1	5.3	2.9	—	—	—	2.0	245
July	72.9	17.7	7.3	1.0	—	—	—	1.0	96
August	18.4	10.4	19.5	26.8	19.9	4.0	0.4	0.6	478
September ..	16.2	10.5	8.4	17.2	9.8	29.3	6.4	2.4	297
October	47.1	11.2	1.1	3.2	1.1	—	—	36.4	187
November ..	19.7	2.2	5.9	12.6	3.4	0.2	0.8	55.1	641
December ..	2.6	9.8	0.8	5.4	5.9	—	2.8	72.7	388

B. Vert S. (Actual Numbers – All age-groups)

Month	Number of Vertebrae 54	55	56	57	58	59	Mean	No.
January	—	6	38	46	3	1	56.52	94
February ...	—	1	22	25	1	—	56.53	49
April	—	2	47	37	8	1	56.57	95
May	—	2	71	99	19	1	56.72	192
June	—	1	32	52	10	1	56.77	96
July	—	—	14	30	3	—	56.77	47
August	—	9	61	93	12	—	56.62	175
September ..	—	2	66	69	4	1	56.55	142
October	—	—	11	34	5	—	56.88	50
November ..	—	9	93	118	20	—	56.62	240
December ..	—	4	57	73	10	—	56.62	144

C. K_2 (Actual Numbers – All age-groups)

Month	Number of Keeled Scales 12	13	14	15	16	17	18	19	Mean	No.
January	2	15	48	30	1	—	—	—	14.18	94
February ...	—	17	19	10	1	—	—	—	13.81	49
April	—	12	48	31	1	—	—	—	14.23	92
May	—	32	82	57	6	—	—	—	14.21	177
June	—	7	51	25	4	2	—	—	14.36	89
July	1	8	21	13	3	1	—	—	14.26	47
August	1	29	77	41	3	—	—	—	14.11	151
September ..	—	13	75	42	11	1	—	—	14.38	142
October	—	8	20	17	1	—	—	—	14.24	46
November ..	4	39	109	79	15	—	—	—	14.25	246
December ..	1	22	69	46	8	1	—	—	14.28	147

D. Pectoral Fins (Actual Numbers – All age-groups)

Month	Number of Fin Rays 14	15	16	17	18	19	20	21	Mean	No.
January	—	1	12	45	34	3	—	—	17.27	95
February ...	—	—	2	31	14	1	—	1	17.37	49
April	—	1	9	42	37	2	1	—	17.36	92
May	—	1	17	66	51	12	—	—	17.38	147
June	—	1	10	51	29	5	—	—	17.28	96
July	—	—	8	32	7	—	—	—	16.98	47
August	—	1	35	84	51	5	—	—	17.14	176
September ..	—	—	15	62	56	12	—	—	17.45	145
October	—	—	11	27	12	—	—	—	17.02	50
November ..	—	1	25	126	81	12	—	—	17.32	245
December ..	—	1	20	64	50	11	—	—	17.34	146

Table 40. Percentage of spring and autumn spawners, North Minch 1961

Period		January–March			April–June			July–September			October–December		
Year-class	Rings	No.	% Spr.	% Aut.	No.	% Spr.	% Aut.	No.	% Spr.	% Aut.	No.	% Spr.	% Aut.
1959–60	1	—	—	—	—	—	—	16	68.8	31.2	17	70.6	29.4
1958–59	2	7	71.4	28.6	82	9.8	90.2	181	16.0	84.0	89	23.6	76.4
1957–58	3	260	20.0	80.0	216	7.9	92.1	322	11.2	88.8	327	11.9	88.1
1956–57	4	271	1.9	98.1	83	7.2	92.8	115	5.2	94.8	218	6.0	94.0
1955–56	5	143	—	100.0	52	—	100.0	38	2.6	97.4	82	2.4	97.6
1954–55	6	163	1.2	98.8	19	—	100.0	18	5.6	94.4	69	1.4	98.6
1953–54	7	36	2.8	97.2	14	—	100.0	14	—	100.0	9	—	100.0
1952–53	8	32	3.1	96.9	7	—	100.0	9	—	100.0	13	—	100.0
1951–52 and older	>8	32	—	100.0	3	—	100.0	5	—	100.0	6	—	100.0
Total		944	8.7	92.3	476	6.5	93.5	718	11.7	88.3	830	10.6	89.4

Table 41. Percentage of spring and autumn spawners, South Minch 1961

Period		January–March			April–June			July–September			October–December		
Year-class	Rings	No.	% Spr.	% Aut.	No.	% Spr.	% Aut.	No.	% Spr.	% Aut.	No.	% Spr.	% Aut.
1959–60	1	—	—	—	—	—	—	85	40.0	60.0	130	55.4	44.6
1958–59	2	7	28.6	71.4	170	16.5	83.5	257	4.7	95.3	248	16.5	93.5
1957–58	3	146	11.0	89.0	584	9.9	90.1	311	3.5	96.5	401	36.2	63.8
1956–57	4	92	3.3	96.7	76	7.9	92.1	114	1.8	98.2	194	18.6	81.4
1955–56	5	55	1.8	98.2	38	—	100.0	31	—	100.0	89	4.5	95.5
1954–55	6	42	7.1	92.9	25	4.0	96.0	30	—	100.0	86	10.5	89.5
1953–54	7	17	5.9	94.1	12	—	100.0	13	—	100.0	20	—	100.0
1952–53	8	17	—	100.0	20	—	100.0	19	—	100.0	34	11.8	88.2
1951–52 and older	>8	16	—	100.0	15	—	100.0	10	—	100.0	14	—	100.0
Total		392	5.6	94.4	940	9.9	90.1	870	6.8	93.2	1,216	25.6	74.4

C. Clyde

(Tables 42–43)

The Fishery

A brief description of the Clyde spawning fishery was given in Vol. **17** (1960). The catch and effort statistics of the two portions of this fishery are given, for the years 1957—61, in Table 42. The marked increase in the total catch and the catch/landing in the ring-net fishery in 1960 was maintained in the 1961 season. The 1957 year-class was again the mainstay of the S. Arran fishery, contributing over 60% of the total catch. The bulk of the remainder was composed of recruit spawners, of the 1958 year-class. In the anchor-net fishery on Ballantrae Bank the 1958 year-class was the dominant one, yielding over 70% of the fish caught, with the 1957 year-class providing practically all of the remainder.

Biological Data

Only the 1957 and 1958 year-classes were present in the samples in adequate numbers to justify the presentation of length and meristic data. These are given in Table 43. As usual, the recruit spawners from S. Arran were significantly smaller than those from Ballantrae Bank; in meristic characters the two groups were virtually identical. The four year-old fish showed no significant differences in either length or meristic characters between the two spawning grounds.

Table 42. Statistics of Clyde spawning fishery, 1956/1961

	1956	1957	1958	1959	1960	1961
	Ring-Net Fishery					
Number of landings	189	108	284	180	562	1,094
Total catch (crans)	1,183	558	302	938	10,463	18,750
Catch/landing (crans)	6.3	5.2	1.1	5.2	18.6	17.1
	Trammel-Net Fishery					
Number of landings	147	141	138	82	101	56
Total catch (crans)	401	765	641	420	704	494
Catch/landing (crans)	2.7	5.4	4.6	5.1	7.0	8.8

Table 43. Mean length and meristic data of 1957 and 1958 year-classes in Clyde spawning fishery, 1961

	Mean Length	Vert. S.	K_2	Pectoral Fin
3-ringers Ballantrae ...	25.88 (249)	57.03 (107)	14.17 (102)	16.65 (107)
4-ringers Ballantrae ...	27.17 (93)	57.08 (24)	14.25 (24)	16.74 (27)
3-ringers S. Arran	24.86 (271)	57.04 (95)	14.14 (97)	16.79 (85)
4-ringers S. Arran	27.10 (416)	57.08 (133)	14.01 (144)	16.87 (103)

Table 44. Scottish herring tagging, 1961

Recaptures

Area	Number	Days of liberty
South Minch	101	0–147
Clyde	14	92–159
South Minch	7	28–105
Clyde	98	4–140

Liberations

Area	Period	Type	Number
South Minch	November	Scottish Combination	3,867
		Internal	1,833
Clyde	November	Scottish Combination	1,091

D. Tagging

(Table 44)

Two tagging experiments were carried out during November 1961 in the South Minch and in the Firth of Clyde. The details of liberations and recaptures are given in Table 44.

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I. G. Baxter, G. McPherson

Errata. Vol. XVII (1960) 1962:

Figure 9, p. 181 read "Length and age composition of South Minch drift-net (January/March and June) and ring-net (May and July/December) samples (length frequencies unsmoothed)."

Figure 11, p. 184, read "Length and age composition of north-western North Sea drift-net samples May/September 1960 (length frequencies unsmoothed)".

Survey of the German Commercial Herring Fisheries in 1961

(Charts 1–2; Tables 45–51)

A. The Fisheries

The total landings of herring by the German fishing fleet, which amounted to 126,000 tons, are shown in Table 45. The total catch decreased further, by 31.9% (59,000 tons) compared with 1960. 80.5% of the total (101,000 tons) consisted of herring for human consumption and 19.5% (24,600 tons) of industrial herring. The decline in the landings is mainly due to the smaller catches of the trawlers and drifters in the North Sea (35.6% = 48,300 tons) as well as the deep-sea cutters for factory herring (38.2% = 13,400 tons).

1. Trawlers

The catch of the trawlers decreased from 70,000 tons in 1960 to 34,000 tons (48.6%) in 1961, the number of trips from 886 to 431 (48.6%), and the fishing days from 7,859 to 3,747 (47.7%). The decline is mainly due to the smaller catch in the North Sea (52.7% = 34,042 tons), while those from the Channel, SE Ireland and north of the Hebrides increased slightly. The number of trips in the North Sea fell off from 819 in 1960 to 388 in 1961, the fishing days from 8,821 to 3,518. The catch per day's fishing increased slightly from 8.7 tons to 9.0 tons in this area.

(a) The *spring fishery* in the North Sea was centred from *Viking Bank to Utsira* ('Ostkante')

Table 45. Total herring landings (in 1,000 tons) of the German fishing fleet in 1961

(In parentheses 1960)

	North Sea	Channel	SE Ireland	N Ireland	N of Hebrides	Other areas	Total
Trawlers	30.5 (65)	1.1 (+)	0.7 (+)	0.4 (3)	1.3 (1)	+[1])(—)	34.0 (70)
Drifters	43.2 (57)	7.6 (4)	— (—)	— (+)	— (+)	— (+)	50.8 (61)
Fresh herring	9.1 (13)	+ (+)	— (—)	— (—)	— (—)	— (—)	9.1 (13)
Drift-net	0.4 (3)	—	— (—)	— (—)	— (—)	— (—)	0.4 (3)
Trawl	8.7 (10)	+ (+)	— (—)	— (—)	— (—)	— (—)	8.7 (10)
Salt herring	34.1 (44)	7.6 (4)	— (—)	— (+)	— (+)	— (+)	41.7 (48)
Drift-net	24.2 (34)	4.0 (2)	— (—)	— (+)	— (+)	— (+)	28.2 (36)
Trawl	9.9 (10)	3.6 (2)	— (—)	— (—)	— (—)	— (—)	13.5 (12)
Deep-sea cutters	27.1 (39)	— (—)	— (—)	— (—)	— (—)	14.2[2])(15)	41.3 (54)
for consumption ..	4.5 (2)	— (—)	— (—)	— (—)	— (—)	12.2 (14)	16.7 (16)
for factories	22.6 (37)	— (—)	— (—)	— (—)	— (—)	2.0 (1)	24.6 (38)
Total	100.8 (161)	8.7 (5)	0.7 (+)	0.4 (3)	1.3 (1)	14.2 (15)	126.1 (185)

[1]) Norwegian coast. [2]) Mainly Baltic Sea.

from January to June. The total landings decreased from 10,867 tons to 1,819 tons. 78 trips were made compared with 214 in 1960. The catch per day's fishing dropped from 5.0 to 2.4 tons. The main catch was from February to March. One trip in March from the Shetland and Otter Bank area produced 11 tons of herring in 12 fishing days.

(b) The *summer/autumn* fishery started at the end of June and lasted until the end of August. Fishing was carried out in the *Bressay area*, and in mid-July there was a small fishing on the *Fladen Ground*. The total landings decreased from 23,638 tons in 1960 to 1,816 tons in 1961, a decrease of 92.3%. The number of trips fell off from 345 to 18, the fishing days from 3,029 to 171 and the catch per day's fishing from 11.2 to 10.9 tons. The main catch was taken in August but the highest catch per day was taken in September (22.2 tons).

The *Gut* fishery was also of small importance in 1961. Only 5 trips were made in August and September. The total yield decreased from 1,202 to 586 tons but the catch per day increased from 9.7 to 15.0 tons.

On the *Dogger Bank* grounds, fishing started about 20. August and ended after 10. October. The number of trips declined from 126 to 105, the total yield from 13,713 tons to 11,637 tons (15.1%), but the catch per day's fishing increased from 12.7 to 14.1 tons.

The total catch of the trawler fleet in the customary fishing areas in the North Sea in the summer/autumn fishery decreased by 63.6%, from 38,553 tons in 1960 to 14,039 tons in 1961.

(c) In the *Channel* fishery 12 trips were made in December, mainly in the Dieppe area. The total yield, 260 tons, was about the same as in 1960, and the catch per day was 9.3 tons.

(d) 31 trips were made to the *west coast of Great Britain* in January, February, July, August, October/December. The total yield decreased from 4,974 tons to 2,423 tons, but the catch per day increased from 10.3 to 13.3 tons.

Eleven of these trips, in January (7 trips), February (1 trip) and December (3 trips) were made to *South Ireland*. The total catches in these months were 406, 15 and 306 tons respectively and the catches per day were 25.4, 5.0 and 14.6 tons. Eight of the trips, in October (7 trips) and November (1 trip), were made to the *North of Ireland*. The total catches in these months were 281 and 138 respectively. The catches per day were 4.8 and 17.3 tons.

From July to November, 12 trips were made in the area to the *North of the Hebrides* and yielded 1,276 tons. The main catch, 945 tons, was made in August. The catch per day increased from 13.0 to 16.0 tons.

(e) From October to December fishing was resumed in the *Utsira* (*'Ostkante'*) area. The catch decreased from 6,125 tons from 113 trips in 1960 to 4,448 tons from 66 trips in 1961, while the catch per day's fishing increased from 6.2 to 7.7 tons.

2. Drifters

The total yield of this fishery decreased about 16.3%, from 60,760 tons in 1960 to 50,874 tons in 1961. 28,601 tons (56.2%) were caught with drift-nets and 22,273 tons (43.8%) with trawl.

The catch in the North Sea amounted to 43,274 tons. 377 tons with drift-nets, and 8,745 tons with trawl were caught as fresh herring, and 24,237 tons with drift-nets and 9,965 with trawl as salted herring. From the Channel came 7,600 tons (drift-net 3,987 tons, trawl 3,613 tons); 16 tons of these were landed as fresh herring.

Chart 1 shows the monthly distribution of the mean catch and the number of hauls for the drift-net fishery, and Chart 2 for the trawl fishery in 1961. The fresh herring season lasted from January to November for the trawl and from April to September for the drift-net. The total catch decreased from 13,144 tons to 9,138 tons, the number of trips from 387 to 374. Only 4.1% of the yield was caught by drift-net and 95.9% by trawl. The fishing grounds were *Ling Bank, Utsira, Bressay Shoal, Shetlands, Fladen Ground, Dogger Bank, Gut, Great Fisher Bank, 'Binnensee', and the Channel.* The main catch was made with drift-nets from May to June in the *Utsira/Bressay* area. The catch per day for the drift-nets were between 0.9 and 4.5 tons (average 3.3 tons), and for the trawl between 0.2 and 6.7 tons (average 2.4 tons).

From the North Sea 34,152 tons of salted herring from 425 trips were landed, between May and December compared with 44,098 tons from 479 trips in 1960. The smaller catch (22.6%) was due to decreased effort and catch per day. 71.0% were caught by drift-net and 29% by trawl. The catch per day decreased from 4.1 to 3.4 tons (drift-net) and from 5.0 to 4.3 tons (trawl).

In the *Fladen/Bressay* area the catch decreased from 9,646 tons to 6,034 tons. 1,922 tons were taken by drift-nets and 4,112 tons by trawl. Fishing by drift-net in this area took place between May and August, but the main catch was made in June in the northern part of the area. The trawl fishery took place between May and October, but the main catch was taken in July and August. The catch per day on the northern grounds was

Lugger Monthly - Charts 1961
(Drift - Net)

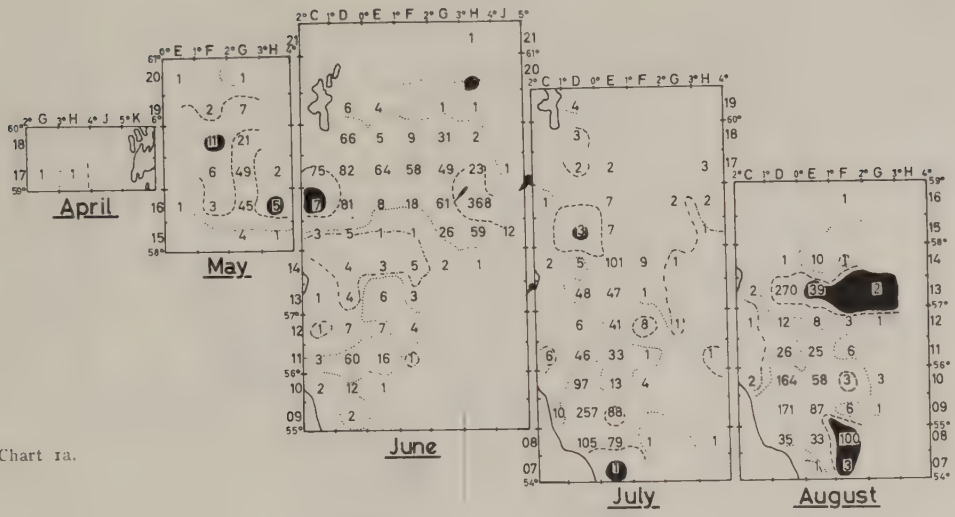

Chart 1a.

Lugger Monthly - Charts 1961
(Drift - Net)

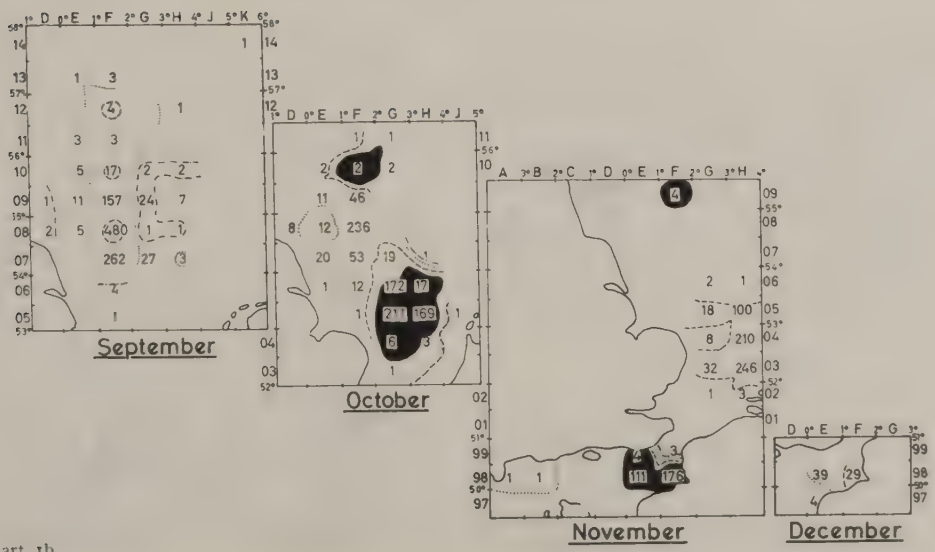

Chart 1b.

Lugger Monthly - Charts 1961
(Trawl)

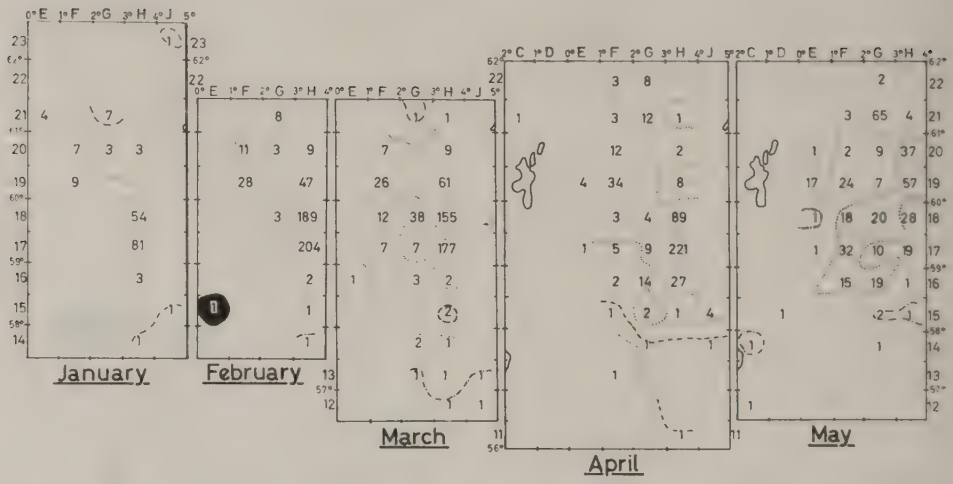

Chart 2a.

Lugger Monthly - Charts 1961
(Trawl)

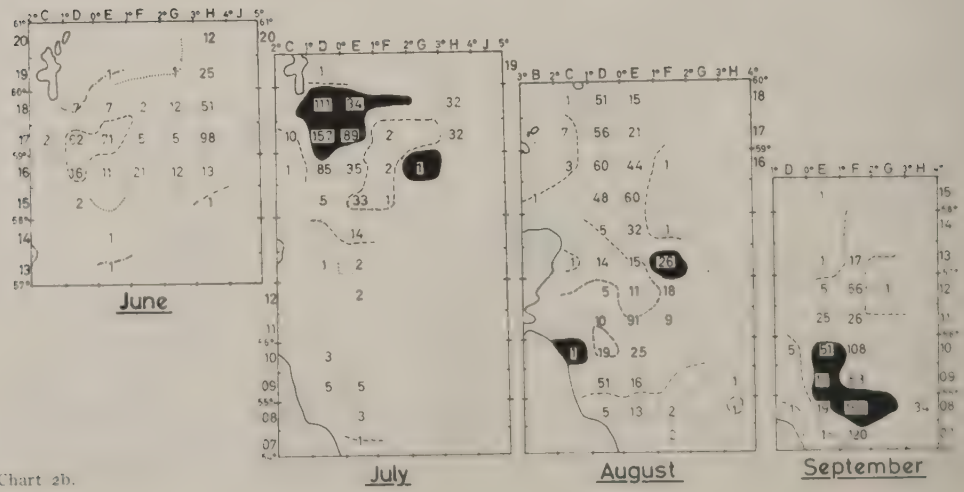

Chart 2b.

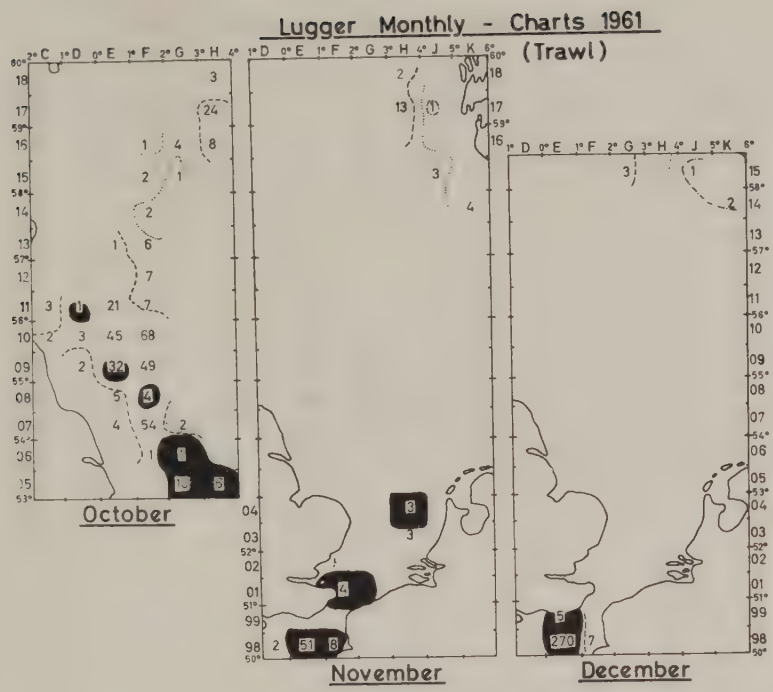

Chart 2c.

2.6 tons, and on the southern grounds 2.3 tons (drift-net). For the trawl the catches per day were 5.1 and 3.9 tons respectively. Both drift-net and trawl catches per day showed a decrease compared with 1960.

In the *Gut*, the yield dropped from 9,328 tons in 1960 to 3,530 tons in 1961. 2,404 tons were caught by drift-net and 1,126 tons by trawl. Fishing by drift-net and trawl took place from July to October. The catch per day decreased from 4.3 tons (1960) to 2.7 tons (drift-net) and from 4.7 tons (1960) to 3.5 tons (trawl).

In the *Dogger Bank* area, the yield increased from 13,959 tons to 14,518 tons, but the catch per day for the drift-net dropped from 4.4 to 2.9 tons. The catch for the trawl increased from 3.9 to 4.5 tons. The main fishing by drift-net was from August to October, and by trawl from September to October.

The yield in the *Southern Bight* ('Binnensee') decreased slightly from 7,765 tons to 6,929 tons, while the catch per day increased from 4.2 to 5.8 tons. The main fishing was in October/November.

In the *Channel* the yield increased from 3,484 tons to 7,584 tons; 3,987 tons were taken by drift-nets and 3,597 by trawl. The main fishing by drift-net took place in November, and by trawl, in December, in the Dieppe area. The catch per day by drift-net increased from 2.0 to 7.0 tons, and by trawl from 6.4 to 6.7 tons.

3. Cutters

The total yield of herring for human consumption from the deep-sea and coastal cutters in the North Sea increased from 2,000 in 1960 to 4,500 tons in 1961. The deep-sea cutters made 155 trips from July to November. The main catch was made in October when the catch increased from 446 to 1,704 tons. The total catch of industrial herring from the deep-sea cutters in the North Sea decreased from 36,516 tons to 22,600 tons. The main catch came from the oil herring fishery which declined from 22,196 to 16,704 tons.

B. Biological Data

1. Svinøy

One sample of 81 herring was taken in February from an experimental voyage by a drifter to this area. The average length of the herring was 33.85 cm (Table 46). All fish were in maturity stage V (Table 47) and consisted mainly of over 9 year-old herring

Table 46. Length composition of all samples (‰)

	1	2							3			4	5	
Area	Svinøy	Viking Bank/Utsira							Bressay Shoal			Fladen Ground	Gut	
Gear	D	PT	T	T	PT	T	T	T	T	T	T	T	T	T
Samples	S	S	S	S	S	M	M	M	S	M	M	S	S	S
Month	II	I	III	IV	IV	X	XI	XII	IV	VII	VIII	IV	IV	IX
cm 37	12	—	—	—	—	—	—	—	—	—	—	—	—	—
36	74	—	—	1	—	—	1	—	—	—	—	—	—	—
35	111	2	—	5	—	—	—	—	—	—	—	—	—	—
34	148	—	—	7	—	—	—	—	—	1	—	—	—	—
33	**371**	8	—	25	—	4	1	—	—	1	—	—	—	—
32	272	8	24	31	2	5	4	2	—	1	1	—	—	6
31	12	47	16	54	22	6	15	26	11	3	13	10	—	24
30	—	93	73	90	88	64	77	111	33	17	52	20	—	46
29	—	107	32	138	125	113	146	149	110	49	130	27	—	70
28	—	205	145	228	192	279	264	206	154	119	286	31	—	152
27	—	**287**	**323**	**262**	**265**	**312**	**293**	**291**	165	283	**320**	191	26	**236**
26	—	158	185	117	169	153	114	162	**208**	**306**	125	**342**	79	202
25	—	70	113	30	68	36	33	37	165	157	43	239	187	155
24	—	—	65	8	35	13	7	4	99	55	15	92	**325**	92
23	—	10	8	1	22	1	5	2	33	8	9	41	264	15
22	—	5	8	3	9	5	5	4	22	—	4	—	90	2
21	—	—	8	—	3	5	20	4	—	—	1	—	24	—
20	—	—	—	—	—	4	10	2	—	—	1	—	5	—
19	—	—	—	—	—	—	5	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14	—	—	—	—	—	—	—	—	—	—	—	—	—	—
13	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number ...	81	600	124	766	1159	770	816	458	91	713	2677	293	379	862
Average, cm	33.85	28.13	27.39	28.67	27.74	27.92	27.91	28.13	26.94	26.99	27.94	26.36	24.39	27.20

T = Trawl — D = Drift-Net — PT = Pelagic Trawl

(988‰) (Table 48). The average number of vertebrae was 57.08, of keeled scales 13.96, and of gill rakers 48.87 (Tables 49—51). The catch consisted of late winter spawners of Atlanto-Scandian type.

2. Viking Bank/Utsira ('Ostkante')

4,693 herring, caught between January and December were examined. The average lengths of the herring in the samples in January, March and April were between 27.13 cm and 28.67 cm and, in October to December, between 27.91 and 28.13 cm. The mode of the length composition was, in all samples at 27 cm (Table 46). Table 47 shows that in all months maturity stage II predominated but in the March and April samples stage VII was prominent.

The age composition of the catches (Table 48) indicates that in all months, 5 year-old herring (1956 year-class) were the most abundant.

In late winter and spring, the average number of vertebrae fluctuated between 56.61 and 56.88, while in autmn, these values were 56.54 to 56.66. The number of keeled scales were 14.11 to 14.47 and the number of gill rakers 46.59 to 47.08.

The average values of the different meristic characters, by maturity stages, are given in Tables 49—51. These indicate that, in all months, autumn spawners were more prominent than late winter and spring spawners.

3. Bressay Shoal

In April, July and August, 3,481 herring were examined. The average length was 26.94 to 27.94 cm (Table 46). In April, maturity stages II and VII were predominant, while in July, stages IV and V, and in August V, VII/II, IV and II were the main ones (Table 47). The age composition (Table 48) shows the predominance of 5 year-old herring (1956 year-class) in all months. In April the 7 (1954), 4 (1957) and over 9 year-old fish had some importance. In July the 4 (1957), and in August the 3 (1958) and 4 year-old fish were more frequent.

Table 46. Length composition of all samples (‰) (continued)

	6				7		8	9		10			11	
Area	Dogger Bank				Binnen-see		Sandet-tié	Channel		Skagerak			Egersund	
Gear	T	T	T	T	T	T	T	T	D	T	PT	PT	T	PT
Samples	S	M	S	M	S	S	S	S	S	S	S	S	S	S
Month	IX	IX	X	X	I	XI	XI	XI	XI	III	IX	X	III	IX
cm 37	—	—	—	—	—	—	—	—	—	—	—	—	—	—
36	—	—	—	—	—	—	—	—	—	—	—	—	—	—
35	—	—	—	—	—	—	—	—	—	—	—	—	—	—
34	—	—	—	—	—	—	—	—	—	—	1	—	—	—
33	—	—	—	—	—	—	—	—	—	1	4	—	—	—
32	1	—	+	—	—	—	—	—	—	3	7	1	—	10
31	7	1	2	2	1	—	—	—	—	7	14	3	33	10
30	14	12	8	2	1	—	—	5	—	12	38	10	39	51
29	26	29	18	22	3	—	—	5	—	11	97	45	24	164
28	65	77	52	52	3	7	10	49	10	**17**	**157**	99	81	**307**
27	136	147	131	161	14	24	31	92	40	13	146	**101**	**111**	234
26	**158**	161	162	**244**	24	72	75	146	148	14	103	88	87	92
25	156	**178**	**175**	214	93	154	134	237	246	19	52	96	84	51
24	121	184	171	190	134	267	279	**282**	**320**	43	42	119	84	41
23	81	136	75	77	**135**	**271**	**362**	164	189	85	69	**145**	**153**	20
22	42	63	11	36	63	166	101	19	44	**131**	64	111	132	10
21	18	9	2	—	67	29	8	1	3	120	**76**	83	123	—
20	7	2	1	—	29	10	—	—	—	96	70	66	39	10
19	2	1	—	—	27	—	—	—	—	**118**	43	22	7	—
18	—	—	+	—	34	—	—	—	—	76	13	8	—	—
17	2	—	9	—	63	—	—	—	—	49	4	2	—	—
16	21	—	68	—	**130**	—	—	—	—	54	—	1	—	—
15	**114**	—	**99**	—	128	—	—	—	—	**54**	—	—	—	—
14	28	—	15	—	40	—	—	—	—	44	—	—	3	—
13	1	—	+	—	10	—	—	—	—	26	—	—	—	—
12	—	—	1	—	1	—	—	—	—	6	—	—	—	—
11	—	—	—	—	—	—	—	—	—	1	—	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	100	1000	1000
Number ...	3136	1960	3876	504	792	416	387	831	297	1597	1471	1954	33	98
Average, cm	24.14	25.67	23.98	25.88	20.65	24.17	24.33	25.35	24.92	20.65	25.71	24.71	25.00	27.86

T = Trawl — D = Drift-Net — PT = Pelagic Trawl

The average numbers of vertebrae were 56.58, 56.59 and 56.53, of keeled scales 14.40, 14.21, 14.43, and of gill rakers 46.76, 46.87 and 46.59.

The meristic characters (Tables 49—51) show that in all months the autumn spawning component was large and that the proportion of spring spawners was very low.

4. Fladen Ground

In April, 293 herring were investigated. The average length was 26.36 cm (Table 46). Maturity stages I and II were predominant (Table 47). The most abundant age-group was the 5 year-olds (1956 year-class), followed by the 4 (1957 year--class) and 3 (1958 year-class) year-old fish (Table 48).

The average number of vertebrae was 56.52, of keeled scales 14.40, and of gill rakers 46.40.

The meristic characters show that the sample consisted of autumn spawners. Only one fish was a spring spawner (Tables 49—51).

5. Gut

1,241 herring from this area were examined in April and September. The average lengths were 24.39 cm and 27.20 cm respectively (Table 46).

In April, maturity stages II and I were predominant (Table 47), while in September stages IV, II, VII/II and V were the most abundant.

The 4 and 3 year-olds predominated in April. Also, the 1956 year-class (5 year-old) had some importance in this month. In September mainly the 3, 5 and 4 year-old fish made up the catch (Table 48).

The data for the average number of vertebrae were 56.41 in April and 56.57 in September, for keeled scales 14.61 and 14.77, and for gill rakers 46.14 and 46.14.

The meristic characters in relation to maturity stages show (Tables 49—51) that, in April and

Table 46. Length composition of all samples (‰) (continued)

	12		13		14			15	16	17	
Area	Gr. Fisher Bank		Jutiandbank		East of Dogger			C. Wrath	Dunmore	Hebrides	
Gear	T	T	T	T	T	T	T	T	T	T	T
Samples	S	S	S	S	S	S	S	M	M	M	M
Month	III	IX	III	X	IV	IX	X	VIII	XII	X	XI
cm 37	—	—	—	—	—	—	—	—	—	—	—
36	—	—	—	—	—	—	—	—	—	—	—
35	—	—	—	—	—	—	—	—	—	—	—
34	—	—	—	—	—	—	—	—	—	—	—
33	—	—	—	—	—	—	—	—	—	2	—
32	—	—	—	—	—	—	—	—	—	2	2
31	—	—	—	—	—	+	—	4	—	7	2
30	—	—	—	—	—	+	1	35	9	36	21
29	—	4	—	7	—	3	—	100	37	60	68
28	—	4	—	51	—	10	3	189	59	98	87
27	—	24	—	117	—	10	9	**259**	99	226	255
26	—	43	—	234	—	20	27	252	164	**296**	**323**
25	—	**94**	—	**256**	—	43	78	125	**231**	226	184
24	—	86	—	131	—	**50**	**147**	32	164	40	50
23	43	59	—	**153**	28	43	146	3	151	7	8
22	87	16	—	22	28	20	44	1	79	—	—
21	**304**	—	—	22	56	6	8	—	7	—	—
20	262	8	148	7	111	6	1	—	—	—	—
19	**304**	—	**408**	—	167	2	—	—	—	—	—
18	—	20	333	—	193	3	—	—	—	—	—
17	—	—	111	—	**222**	11	14	—	—	—	—
16	—	47	—	—	139	92	65	—	—	—	—
15	—	255	—	—	56	165	132	—	—	—	—
14	—	**313**	—	—	—	**259**	**178**	—	—	—	—
13	—	27	—	—	—	220	91	—	—	—	—
12	—	—	—	—	—	35	47	—	—	—	—
11	—	—	—	—	—	2	8	—	—	—	—
10	—	—	—	—	—	—	1	—	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	23	255	27	137	36	2498	1929	1133	456	420	515
Average, cm	20.80	18.43	19.09	25.52	18.61	16.77	19.14	27.39	25.50	26.98	26.93

T = Trawl — D = Drift-Net — PT = Pelagic Trawl

September herring from the North Sea autumn group populated the area.

6. Dogger Bank area

9,486 herring were examined in September and October. The average lengths were 23.98 to 25.88 cm (Table 46). In September, maturity stages IV and VI formed the bulk of the catch, whereas in October, stages IV, V, I and VII were abundant (Table 47).

The predominant age-group was the 3 year-olds (1958 year-class), but the 4 and 5 year-olds were also prominent (Table 48).

The average number of vertebrae were 56.41 to 56.52, of keeled scales 14.64 to 14.68, and of gill rakers 45.64 to 46.14.

Autumn spawners frequented the area in this month (Tables 49—51).

7. Southern Bight ('Binnensee')

1,208 herring were investigated in January and November. The average lengths were 20.65 and 24.17 cm (Table 46). In January, maturity stages I and II and, in November, stage VI predominated (Table 47).

The age composition shows (Table 48) that in January the 2 year-old herring (1959 year-class) were the most abundant, while 4 and 3 year-old fish were also prominent. In November, 3 year-olds predominated.

The average number of vertebrae was 56.53, of keeled scales 14.78, and of gill rakers 45.41. In November these values were 56.43, 14.93, and 45.63 respectively.

The meristic characters show that the herring belonged to both autumn spawning groups of the North Sea. (Tables 49–51).

8. Sandettié

387 herring were examined in November. The average length was 24.33 cm (Table 46). The bulk of the catch was in maturity stage VI (Table 47). The age distribution shows the predominance of 3 year-old herring (Table 48).

Table 47. Sexual maturity in all samples (‰)

Area	Svinøy	Viking Bank/Utsira							Bressay Shoal			Fladen Ground
Gear	D	PT	T	T	PT	T	T	T	T	T	T	T
Samples	S	S	S	S	S	M	M	M	S	M	M	S
Month	II	I	III	IV	IV	X	XI	XII	IV	VII	VIII	IV
Stages I	—	55	101	17	56	40	5	51	53	20	10	**517**
II	—	**890**	**595**	**602**	**907**	**830**	**914**	**898**	**684**	10	133	479
III	—	—	7	5	—	70	25	10	11	20	59	—
IV	—	48	20	5	—	30	20	41	11	**840**	180	—
V	**1000**	7	—	2	—	—	—	—	—	110	**343**	—
VI	—	—	27	14	—	—	—	—	—	—	6	—
VII	—	—	250	355	37	30	36	—	241	—	57	4
VII/II	—	—	—	—	—	—	—	—	—	—	212	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	81	146	148	417	161	100	197	98	95	100	490	234

Area	Gut		Dogger Bank				Binnensee		Sandettié	Channel		Skagerak	
Gear	T	T	T	T	T	T	T	T	T	T	D	T	PT
Samples	S	S	M	S	M	S	S	S	S	S	S	S	S
Month	IV	IX	IX	IX	X	X	I	XI	XI	XI	XI	III	IX
Stages I	455	12	17	160	—	187	**622**	11	—	4	3	**808**	**518**
II	**536**	241	23	139	30	80	351	11	—	5	7	90	103
III	—	67	94	130	111	63	6	—	—	—	3	9	172
IV	9	**271**	147	**236**	**374**	**240**	3	42	2	25	24	20	138
V	—	126	327	145	313	176	—	18	2	56	290	16	69
VI	—	22	**352**	52	—	47	12	**895**	**986**	**895**	**663**	36	—
VII	—	39	40	68	172	108	6	18	10	12	10	21	—
VII/II	—	222	—	70	—	99	—	5	—	3	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	112	406	395	1104	99	1382	347	379	509	755	297	701	29

Area	Egersund	Gr. Fisher Bank		Jutland Bank	East of Dogger			Cape Wrath	Dunmore	Hebrides	
Gear	T	T	T	T	T	T	T	T	T	T	T
Samples	S	S	S	S	S	S	S	M	M	M	M
Month	III	III	IX	X	IV	IX	X	VIII	XII	X	XI
Stages I	**487**	**880**	**564**	302	**1000**	**629**	**586**	20	—	—	—
II	321	—	—	—	—	2	1	54	—	**485**	**899**
III	9	40	42	36	—	66	30	84	—	71	20
IV	9	—	168	115	—	116	192	331	—	61	41
V	9	40	200	108	—	80	106	**338**	138	10	10
VI	76	—	26	**439**	—	106	84	51	**862**	20	—
VII	89	40	—	—	—	1	1	81	—	61	—
VII/II	—	—	—	—	—	—	—	41	—	292	30
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	224	25	190	139	36	959	777	296	94	99	99

The average number of vertebrae was 56.55, of keeled scales 15.00, and of gill rakers 45.36. The meristic characters show (Tables 49—51) that these herring belonged mainly to the North Sea Bank group.

9. The Channel

1,128 herring were investigated in this area in November. The average lengths of drift-net and trawl samples were 24.92 and 25.35 cm respectively (Table 46) and maturity stage VI was the most abundant (Table 47). 3 year-old herring (1958 year-class) were predominant, followed by the 4 and 5 year-old fish (Table 48).

The average numbers of vertebrae were between 56.67 and 56.78, of keeled scales 14.82 to 14.88, and of gill rakers 45.20 to 45.28. The meristic characters (Tables 49—51) show that these herring belonged to the southerly group of the North Sea.

10. Skagerak

5,022 herring were examined in March, September and October. The average lengths were 20.65, 25.71 and 24.71 cm (Table 46). Maturity stage I was predominant in March and September while in September stages III, IV and II also had some

Table 48. Age composition of all samples (‰)

Area		Svinøy	Viking Bank/Utsira							Bressay-Shoal			Fladen Ground
Gear		D	PT	T	T	PT	T	T	T	T	T	T	T
Samples		S	S	S	S	S	M	M	M	S	M	M	S
Month		II	I	III	IV	IV	X	XI	XII	IV	VII	VIII	IV
Year-class	Age												
1960	1	—	—	—	—	—	—	—	—	—			
59	2	—	—	20	—	—	—	—	10	—	—	—	
58	3	—	7	81	14	49	80	15	—	31	30	154	117
57	4	—	122	237	86	142	100	55	112	124	130	138	305
56	5	—	**613**	**459**	**477**	**556**	**500**	**468**	**480**	**423**	**700**	**427**	**464**
55	6	—	82	54	69	31	60	65	102	41	30	59	25
54	7	—	95	20	115	62	110	161	122	155	70	87	46
53	8	12	54	20	48	49	70	70	51	72	20	49	17
52	9	—	20	41	57	62	20	111	82	41	—	49	13
< 52	> 9	**988**	7	68	134	49	60	55	41	113	20	37	13
Total		1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number ..		81	147	148	419	162	100	199	98	97	100	492	239

Area		Gut		Dogger Bank				'Binnensee'		Sandettié	Channel		Skagerak	
Gear		T	T	T	T	T	T	T	T	T	T	D	T	PT
Samples		S	S	M	S	M	S	S	S	S	S	S	S	S
Month		IV	IX	IX	IX	X	X	I	XI	XI	XI	XI	III	IX
Year-class	Age													
1960	1				89	—	149	—		—				
59	2	9	2	10	52	—	29	**532**	47	8	3	3	323	133
58	3	353	**377**	**493**	**417**	**546**	**491**	150	**916**	**860**	**719**	**792**	**519**	**667**
57	4	**434**	132	78	134	232	137	230	24	102	149	138	66	100
56	5	195	333	318	217	192	151	80	8	22	117	64	35	—
55	6	—	49	38	29	20	18	8	5	6	4	—	10	—
54	7	9	27	15	19	10	10	—	—	2	4	3	11	33
53	8	—	17	10	16	—	6	—	—	—	4	—	6	—
52	9	—	39	33	18	—	6	—	—				11	—
< 52	> 9	—	24	5	9	—	3	—	—	—	—		19	67
Total		1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number ..		113	409	399	1119	99	1408	361	379	509	760	297	707	30

Area		Egersund	Gr. Fisher Bank		Jutland Bank	East of Dogger			Cape Wrath	Dunmore	Hebrides	
Gear		T	T	T	T	T	T	T	T	T	T	T
Samples		S	S	S	S	S	S	S	M	M	M	M
Month		III	III	IX	X	IV	IX	X	VIII	XII	X	XI
Year-class	Age											
1960	1	—	—	**524**	21	—	**561**	**574**	—	—		
59	2	42	80	47	289	**528**	74	18	—	11		
58	3	**441**	**840**	419	**620**	472	343	396	135	319	20	61
57	4	212	—	5	21	—	4	6	**355**	**478**	**557**	**575**
56	5	208	40	5	42	—	14	6	284	85	192	182
55	6	17	—	—	7	—	4	—	57	11	30	51
54	7	8	—	—	—	—	—	—	118	43	121	71
53	8	13	—	—	—	—	—	—	20	—	30	40
52	9	17	—	—	—	—	—	—	17	21	20	10
< 52	> 9	42	40	—	—	—	—	—	14	32	30	10
Total		1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number ..		236	25	191	142	36	978	796	296	94	99	99

importance (Table 47). The 3 year-old herring (1958 year-class) formed the bulk of the catch in both months. In March the 2 year-old and in September the 2 and 4 year-old fish were also abundant (Table 48).

In both months the average numbers of vertebrae were 56.73, 56.97, of keeled scales 14.40, 14.36, and of gill rakers 46.58 and 47.41 respectively.

These data indicate (Tables 49—51) that the main part of the herring consisted of spring spawners, mixed with autumn spawners from the North Sea.

Table 49. Total number of vertebrae (V.S.) in relation to stages of maturity

Area	Svinøy		Viking Bank/Utsira											
Gear	D		PT		T		T		PT		T		T		T	
Samples	S		S		S		S		S		M		M		M	
Month	II		I		III		IV		IV		X		XI		XII	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	—	—	8	56.25	15	56.93	7	57.00	9	56.67	4	56.75	1	57.00	5	56.40
II	—	—	130	56.62	88	56.53	251	56.61	143	56.64	83	56.63	180	56.53	85	56.54
III	—	—	—	—	1	56.00	2	56.50	—	—	7	57.14	5	56.40	1	57.00
IV	—	—	7	56.86	3	56.33	2	57.50	—	—	3	57.00	4	57.23	4	57.00
V	81	57.08	1	57.00	—	—	1	58.00	—	—	—	—	—	—	—	—
VI	—	—	—	—	4	57.00	6	57.00	—		—	—			—	
VII	—	—	—	—	37	56.76	148	56.89	6	56.67	3	56.00	7	56.43	—	—
VII/II .	—	—	—	—	—	—	—	—	—	—	—	—	—	—		—
Total/Mean	81	57.08	146	56.61	148	56.88	417	56.73	158	56.64	100	56.66	197	56.54	95	56.56

Area	Bressay Shoal						Fladen Ground		Gut		
Gear	T		T		T		T		T		T
Samples	S		M		M		S		S		S
Month	IV		VII		VIII		IV		IV		IX
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	5	57.00	2	57.00	6	57.00	121	56.55	51	56.49	5	57.00
II	65	56.52	1	56.00	64	56.41	112	56.49	60	56.33	98	56.58
III	1	58.00	2	56.50	28	56.64	—	—	—	—	27	56.70
IV	1	56.00	82	56.59	88	56.63	—	—	1	57.00	108	56.63
V	—	—	11	56.55	166	56.52	—	—	—	—	52	56.41
VI	—	—	—	—	3	56.67	—	—	—	—	9	57.00
VII	23	56.61	—	—	28	56.50	1	57.00	—	—	16	56.44
VII/II	—	—	—	—	102	56.50	—	—	—	—	88	56.50
Total/Mean	95	56.58	98	56.59	485	56.53	234	56.52	112	56.41	403	56.57

Area	Dogger Bank								Binnensee				Sandettié	
Gear	T		T		T		T		T		T		T	
Samples	M		S		M		S		S		S		S	
Month	IX		IX		X		X		I		XI		XI	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	7	56.43	178	56.41	—	—	259	56.43	216	56.55	4	56.50	—	—
II	9	56.22	154	56.25	2	56.50	110	56.37	122	56.54	4	57.00	—	—
III	36	56.55	144	56.62	11	56.46	87	56.47	2	55.00	—	—	—	—
IV	68	56.50	258	56.58	36	56.58	332	56.61	1	55.00	16	56.81	1	57.00
V	129	56.36	160	56.52	31	56.42	243	56.60	—	—	7	56.29	1	56.00
VI	127	56.51	57	56.65	—	—	65	56.51	4	56.50	328	56.41	489	56.55
VII	17	56.29	75	56.44	16	55.94	149	56.54	2	56.00	7	56.43	4	56.50
VII/II	—	—	78	56.33	—	—	137	56.47	—	—	2	56.50	—	—
Total/Mean	393	56.45	1104	56.48	96	56.41	1382	56.52	347	56.53	368	56.43	495	56.55

Area	Channel				Skagerak				Egersund		Gr. Fisher Bank			
Gear	T		D		T		PT		T		T		T	
Samples	S		S		S		S		S		S		S	
Month	XI		XI		III		IX		III		III		IX	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	3	57.33	1	55.00	567	56.74	15	57.20	109	56.84	22	56.73	107	56.42
II	4	56.00	2	56.00	63	56.28	3	57.00	72	56.50			—	—
III	—	—	1	57.00	6	56.50	5	56.60	2	57.00	1	56.00	8	56.63
IV	19	56.63	6	57.17	14	56.71	4	56.75	2	57.00	—	—	32	56.22
V	40	56.65	84	56.70	11	57.36	2	56.50	2	56.50	1	57.00	38	56.31
VI	665	56.68	194	56.82	25	57.28	—	—	17	57.47	—	—	5	56.40
VII	9	56.33	3	56.67	15	56.93	—	—	20	56.40	1	56.00	—	—
VII/II	2	57.00	—	—		—		—						
Total/Mean ..	742	56.67	291	56.78	701	56.73	29	56.97	224	56.74	25	56.68	190	56.37

Table 49 (continued)

Area	Jutland Bank		East of Dogger						Cape Wrath		Dunmore		Hebrides			
Gear	T		T		T		T		T		T		T		T	
Samples	S		S		S		S		M		M		M		M	
Month	X		IV		IX		X		VIII		XII		X		XI	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	42	56.31	36	56.58	603	56.41	455	56.45	6	56.83	—	—	—	—	—	—
II	—	—	—	—	2	56.00	1	56.00	16	57.49	—	—	48	56.52	89	56.60
III	5	56.00	—	—	63	56.58	23	56.87	25	56.52	—	—	6	57.00	1	57.00
IV	16	56.25	—	—	111	56.39	150	56.52	98	56.56	—	—	6	57.00	4	57.50
V	15	56.67	—	—	77	56.44	82	56.41	99	56.57	13	56.77	1	56.00	1	56.00
VI	61	56.41	—	—	102	56.48	65	56.41	15	56.67	81	56.82	2	56.50	—	—
VII	—	—	—	—	1	57.00	1	57.00	22	56.64	—	—	6	56.83	—	—
VII/II	—	—	—	—	—	—	—	—	11	56.55	—	—	29	56.48	2	56.50
Total/Mean	139	56.37	36	56.58	959	56.43	777	56.47	292	56.63	94	56.81	98	56.58	97	56.63

Table 50. Total number of keeled scales (K_2) in relation to stages of maturity

Area	Svinøy		Viking Bank/Utsira													
Gear	D		PT		T		T		PT		T		T		T	
Samples	S		S		S		S		S		M		M		M	
Month	II		I		III		IV		IV		X		XI		XII	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	—	—	8	14.13	15	14.20	6	14.00	9	14.34	3	13.67	1	15.00	5	13.80
II	—	—	128	14.14	82	14.33	247	14.19	142	14.33	82	14.16	179	14.33	86	14.56
III	—	—	—	—	1	14.00	2	14.50	—	—	7	14.00	6	14.67	1	14.00
IV	—	—	7	13.86	2	15.00	2	14.50	—	—	3	14.00	4	14.25	4	13.50
V	76	13.96	2	13.00	—	—	1	13.00	—	—	—	—	—	—	—	—
VI	—	—	—	—	4	14.50	5	14.00	—	—	—	—	—	—	—	—
VII	—	—	—	—	37	14.57	146	14.26	6	14.67	3	14.67	6	14.00	—	—
VII/II	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total/Mean	76	13.96	145	14.11	141	14.39	409	14.21	157	14.34	98	14.14	196	14.31	96	14.47

Area	Bressay Shoal						Fladen Ground		Gut		
Gear	T		T		T		T		T		T
Samples	S		M		M		S		S		S
Month	IV		VII		VIII		IV		IV		IX
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	5	14.00	2	14.50	5	14.20	119	14.39	50	14.83	5	14.20
II	64	14.38	1	14.00	60	14.18	111	14.41	58	14.42	95	14.55
III	1	13.00	2	14.00	28	14.72	—	—	—	—	28	14.68
IV	1	13.00	73	14.23	85	14.53	—	—	1	15.00	106	15.00
V	—	—	10	14.10	162	14.54	—	—	—	—	50	15.04
VI	—	—	—	—	3	15.33	—	—	—	—	8	15.00
VII	20	14.70	—	—	27	14.37	1	14.00	—	—	15	14.47
VII/II	—	—	—	—	99	14.25	—	—	—	—	88	14.64
Total/Mean	91	14.40	88	14.21	469	14.43	231	14.40	109	14.61	395	14.77

11. Egersund

131 herring were investigated in March and September. The average lengths were 25.00 and 27.86 cm (Table 46). Maturity stages I and II were the most abundant ones in March (Table 47). The 3 year-old herring (1958 year-class), together with 4 and 5 year-olds were predominant in this month (Table 48).

The average values were, for vertebrae 56.74, for keeled scales 14.27, and for gill rakers 46.55.

Spring spawners, mixed with autumn spawners populated this area in March (Tables 49—51).

Table 50 (continued)

Area	Dogger Bank								'Binnensee'				Sandettié	
Gear	T		T		T		T		T		T		T	
Samples	M		S		M		S		S		S		S	
Month	IX		IX		X		X		I		XI		XI	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	7	14.43	171	14.29	—	—	252	14.43	214	14.60	4	15.00	—	—
II	8	14.06	150	14.41	2	14.50	112	14.61	121	15.11	4	15.00	—	—
III	37	14.95	136	14.75	11	15.00	85	14.68	2	13.50	—	-	-	—
IV	55	14.92	279	14.89	36	14.94	330	14.84	1	14.00	16	14.81	1	16.00
V	124	14.65	135	14.82	30	14.90	241	14.80	—	—	7	14.57	1	15.00
VI	136	14.60	57	14.51	—	—	66	14.79	4	15.00	325	14.94	490	15.00
VII	14	14.79	71	14.55	17	14.59	149	14.67	2	15.00	7	15.14	4	14.75
VII/II	—	—	77	14.63	—	—	133	14.53	—	—	1	15.00	—	—
Total/Mean	381	14.69	1076	14.64	96	14.86	1368	14.68	344	14.78	364	14.93	496	15.00

Area	Channel				Skagerak				Egersund		Gr. Fisher Bank			
Gear	T		D		T		PT		T		T		T	
Samples	S		S		S		S		S		S		S	
Month	XI		XI		III		IX		III		III		IX	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	3	15.00	1	15.00	552	14.41	10	14.50	107	14.20	19	14.74	106	14.47
II	4	15.25	2	14.50	60	14.25	3	14.00	73	14.19	—	—	—	—
III	—	—	1	14.00	7	14.41	4	14.75	2	14.00	1	14.00	8	14.75
IV	19	14.95	7	16.00	12	14.17	3	14.33	2	13.50	—	—	32	14.75
V	39	14.87	82	14.84	10	14.00	2	13.50	2	13.50	1	14.00	38	14.87
VI	657	14.80	191	14.87	25	14.44	—	—	16	14.38	—	—	5	15.60
VII	9	15.44	2	14.50	14	14.86	—	—	22	14.99	1	13.00	—	—
VII/II	2	15.00	—	—	—	—	—	—	—	—	—	—	—	—
Total/Mean	733	14.82	286	14.88	680	14.40	22	14.36	224	14.27	22	14.60	189	14.64

Area	Jutland Bank		East of Dogger						Cape Wrath		Dunmore		Hebrides			
Gear	T		T		T		T		T		T		T		T	
Samples	S		S		S		S		M		M		M		M	
Month	X		IV		IX		X		VIII		XII		X		XI	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	41	14.75	35	14.26	603	14.51	457	14.51	6	14.67	—	—	—	—	—	—
II	—	—	—	—	2	14.00	1	15.00	16	14.19	—	—	48	14.23	88	14.50
III	5	14.20	—	—	57	14.65	21	14.76	23	14.44	—	—	5	13.80	2	13.50
IV	15	14.73	—	—	107	14.84	145	14.95	93	14.40	—	—	6	14.00	4	14.25
V	14	14.83	—	—	71	14.88	81	14.90	90	14.40	14	14.64	1	15.00	1	14.00
VI	60	14.98	—	—	108	14.77	65	14.72	13	14.08	76	14.65	2	14.50	—	—
VII	—	—	—	—	1	17.00	1	15.00	24	14.50	—	—	6	14.50	—	—
VII/II	—	—	—	—	—	—	—	—	12	14.25	—	—	29	14.34	3	15.00
Total/Mean	135	14.84	35	14.26	949	14.61	771	14.66	277	14.38	90	14.65	97	14.26	98	14.48

12. Great Fisher Bank

278 herring were examined in March and September. The average lengths were 20.80 and 18.43 cm (Table 46). Maturity stage I predominated in both months besides, in September, stages V and IV (Table 47). The age composition (Table 48) shows, in March, the predominance of 3 year-old herring (1958 year-class), and in September of the 1 (1960 year-class) and 3 year-old fish.

The average numbers of vertebrae in both months were 56.68, 56.37, of keeled scales 14.60, 14.64, and of gill rakers 45.61 and 45.77.

In March, spring spawners and, in September, mainly autumn spawners from the North Sea populated the area (Tables 49—51).

13. Jutland Bank

164 herring were investigated in March and October. The average lengths were 19.09 and 25.52 cm (Table 46). Maturity stages VI and I were the most abundant, followed by IV and V in October (Table 47). 3 year-old herring (1958 year-class) predominated, followed by 4 year-olds (Table 48).

Table 51. Total number of gill rakers (Rf) in relation to stages of maturity

Area	Svinøy		Viking Bank/Utsira													
Gear	D		PT		T		T		PT		T		T		T	
Samples	S		S		S		S		S		M		M		M	
Month	II		I		III		IV		IV		X		XI		XII	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	—	—	8	46.50	11	47.09	6	47.33	9	47.11	4	48.00	—	—	5	46.80
II	—	—	129	46.87	87	46.73	253	47.25	146	46.94	83	46.93	133	46.68	88	46.98
III	—	—	—	—	1	51.00	2	47.00	—	—	7	48.57	5	48.40	1	48.00
IV	—	—	7	48.86	3	46.00	2	46.50	—	—	3	47.00	1	49.00	4	49.50
V	81	48.87	2	44.50	—	—	1	48.00	—	—	—	—	—	—	—	—
VI	—	—	—	—	2	46.50	5	47.80	—	—	—	—	—	—	—	—
VII	—	—	—	—	34	46.00	136	46.50	6	46.83	3	47.33	7	47.57	—	—
VII/II .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total/Mean	81	48.87	146	46.91	138	46.59	405	47.00	171	46.95	100	47.10	146	46.80	98	47.08

Area	Bressay Shoal						Fladen Ground		Gut			
Gear	T		T		T		T		T		T	
Samples	S		M		M		S		S		S	
Month	IV		VII		VIII		IV		IV		IX	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	5	47.80	2	49.00	5	46.20	119	46.31	49	46.12	5	45.84
II	62	46.81	1	48.00	65	46.71	111	46.47	49	46.14	98	46.47
III	1	45.00	2	45.00	29	45.28	—	—	—	—	27	45.67
IV	—	—	84	46.81	88	46.36	—	—	1	48.00	110	45.67
V	—	—	11	47.18	168	46.62	—	—	—	—	51	45.92
VI	—	—	—	—	3	46.00	—	—	—	—	9	46.33
VII	21	46.43	—	—	28	46.71	1	48.00	—	—	16	47.13
VII/II	—	—	—	—	104	47.04	—	—	—	—	90	46.46
Total/Mean	89	46.76	100	46.87	490	46.59	231	46.40	99	46.15	406	46.14

Area	Dogger Bank								'Binnensee'				Sandettié	
Gear	T		T		T		T		T		T		T	
Samples	M		S		M		S		S		S		S	
Month	IX		IX		X		X		I		XI		XI	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	7	45.43	81	46.21	—	—	49	46.38	24	45.33	4	46.00	—	—
II	9	46.00	153	46.25	3	46.33	103	46.30	126	45.42	4	47.00	—	—
III	37	45.21	144	45.46	11	45.91	86	44.78	3	44.67	—	—	—	—
IV	58	45.62	243	45.62	37	45.84	337	45.26	1	43.00	16	44.81	1	47.00
V	129	46.32	148	46.16	31	45.87	242	45.45	—	—	7	46.14	1	44.00
VI	139	46.47	59	46.14	—	—	66	45.49	4	46.75	339	45.62	502	45.36
VII	16	46.19	74	45.95	17	46.76	153	46.21	2	45.50	7	46.14	5	45.40
VII/II	—	—	78	46.59	—	—	138	46.40	—	—	2	46.00	—	—
Total/Mean	395	46.14	980	45.96	99	46.03	1174	45.67	160	45.41	379	45.63	509	45.36

Area	Channel				Skagerak				Egersund		Gr. Fisher Bank			
Gear	T		D		T		PT		T		T		T	
Samples	S		S		S		S		S		S		S	
Month	XI		XI		III		IX		III		III		IX	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	3	46.67	1	48.00	307	46.33	15	47.40	81	46.93	22	45.45	4	46.25
II	4	46.50	2	46.00	54	47.07	3	48.67	67	45.86	1	49.00	—	—
III	—	—	1	47.00	5	46.80	5	47.60	1	48.00	—	—	8	44.75
IV	19	45.53	7	45.14	14	47.14	4	46.25	2	46.00	—	—	31	45.84
V	42	45.02	86	45.13	8	47.50	2	47.50	1	46.00	—	—	38	45.77
VI	676	45.18	197	45.30	25	48.03	—	—	15	47.53	—	—	5	46.50
VII	9	45.56	3	46.67	14	46.46	—	—	16	46.56	—	—	—	—
VII/II	2	47.00	—	—	—	—	—	—	—	—	—	—	—	—
Total/Mean ..	755	45.20	297	45.28	427	46.58	29	47.41	183	46.55	23	45.61	86	45.77

Table 51 (continued)

Area	Jutland Bank		East of Dogger						Cape Wrath		Dunmore		Hebrides			
Gear	T		T		T		T		T		T		T		T	
Samples	S		S		S		S		M		M		M		M	
Month	X		IV		IX		X		VIII		XII		X		XI	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	2	45.00	19	45.84	61	45.92	11	45.91	6	47.33	—	—	—	—	—	—
II	—	—	—	—	2	44.00	1	46.00	16	48.31	—	—	48	46.60	89	46.70
III	5	46.20	—	—	60	45.38	23	45.17	25	47.88	—	—	7	47.28	2	48.00
IV	15	46.13	—	—	113	45.75	153	45.92	98	46.83	—	—	6	48.17	4	49.00
V	15	45.80	—	—	77	46.30	83	45.90	100	46.94	14	47.21	1	47.00	1	48.00
VI	59	45.78	—	—	110	45.97	67	45.58	15	46.40	74	46.65	2	49.50	—	—
VII	—	—	—	—	1	49.00	1	47.00	24	46.88	—	—	6	47.00	—	—
VII/II	—	—	—	—	—	—	—	—	12	47.08	—	—	29	46.52	3	48.33
Total/Mean	96	45.85	19	45.84	424	46.14	339	45.80	296	47.68	88	45.58	99	46.81	99	46.89

The average number of vertebrae was 56.37, of keeled scales 14.84, and of gill rakers 45.85.

The meristic characters (Tables 49—51) indicate that only Bank herring frequented the area, and also spawned there.

14. East of Dogger

4,463 herring were investigated in April, September and October. The average lengths in these months were 18.61, 16.77 and 19.14 cm respectively (Table 46). In April, only maturity stage I was present, but in September and October stages IV—VI were also of some importance (Table 47). In spring, the stock was composed of 2 (1959 year-class) and 3 year-olds whereas, in autumn, 1 year-olds (1960 year-class) predominated and 3 year-olds (1958 year-class) were also of importance (Table 48).

The average numbers of vertebrae were 56.58, 56.43 and 56.47, of keeled scales 14.26, 14.61 and 14.66, and of gill rakers 45.84, 46.14 and 45.80.

The herring in April were presumably a mixture from both North Sea autumn groups whereas, in autumn, the Bank herring group populated the area in which spawning also took place (Tables 49—51). The proportion of the 1 year-old fish (1960 year-class) was very high.

15. Cape Wrath

1,133 herring were investigated in August. The average length was 27.39 cm (Table 46) and the maturity stages were VI and V (Table 47). 4 (1957 year-class), 5 (1956 year-class), 3 (1958 year-class), and 7 year-olds (1954 year-class) predominated (Table 48).

The average numbers of vertebrae was 56.53, of keeled scales 14.38, and of gill rakers 47.68.

The samples consisted of a mixture of spring and autumn spawners, with the latter predominating (Tables 49—51).

16. Dunmore

456 herring were examined in December. The average length was 25.50 cm (Table 46). Maturity stages VI and V made up the catches (Table 47), and 4 and 3 year-old herring were predominating (Table 48). The average number of vertebrae was 56.81, of keeled scales 14.65, and of gill rakers 45.58.

17. Hebrides

935 herring were investigated in October and November. The average lengths were 26.98 cm and 26.93 cm respectively (Table 46). Maturity stage II predominated in both months but in October, stage VII/II had some importance (Table 47). The age composition (Table 48) shows the predominance of the 4 year-olds (1957 year-class) but in both months, 5 year-old fish were also prominent; in October, 7 year-olds (1954 year-class) were also important.

Conclusions

The main features of this survey are, (1) that the 1959 year-class seems to be poor in the North Sea. (2) It seems that the 1960 year-class is stronger than normal. (3) In the northern North Sea, the strong 1956 year-class, now 5 years old, formed the bulk of the catches. (4) From the Gut to the south there was a change in the age composition. In these areas the catch consisted mainly of 3 year-old (1958 year-class) herring.

K. Schubert

The Herring Fisheries in the Netherlands in 1961

(Tables 52–57)

A. The Fisheries

Trawl

Catch and effort statistics of the herring trawl fishery are presented in Table 52, which shows the total catch (fresh weight), effort (in fishing hours, converted to those of a motor trawler of 500 BHP) and the catch per 100 hours fishing, by month and area. The areas are defined in Ann. Biol., **16**.

The total herring catch of the trawler fleet went up from 51,100 tons in 1960 to 62,800 tons in 1961, whereas the catch per 100 hours fishing increased from 19.1 tons to 21.5 tons.

Considering the fisheries in the different areas and seasons it may be noticed, that in the northern North Sea areas NE (mainly a winter fishery) and NW (mainly a summer fishery) the catches were rather poor compared with 1960 and 1959. In the central North Sea the summer/autumn fishery gave slightly better results than in 1960, but remained well below the 1959 level. The results of the fisheries in the area South (southern North Sea and English Channel) showed a marked improvement both in total catch and in catch per effort over the two preceding years, which were themselves above the average level observed in this area since 1955.

In the area S E of Ireland the fishery was also more successful than in 1960.

In the areas Central and South a pair-trawl fishery also took place: the statistics by month and area are given in Table 53. The total catch of the pair trawlers amounted to 13,709 tons compared with 15,412 tons in 1960. Most of this catch came from area South (12,390 tons).

Drift-net

Table 54 gives the catch statistics for the drift-net fishery in 1961.

Fishing started on 23. May. From 23. May to 12. June the boats were allowed to use 50 nets. After 12. June the numbers of nets used increased to 100 and remained at this level until the end of the season.

The main characteristics of the drift-net fishery in 1961 were as follows:—

The summer fishery (May/August) which takes place in the areas Central and NW, gave results similar to those of 1960, but the catches tended to be better in the area NW, especially in July and August which is different from the situation in 1960. The results of the fishery in both regions in September/October were disappointing compared with 1960 and similar to those of 1959.

Fishing in the area South improved again and the catch per shot (7.0 tons) reached the pre-1955 level (compare trawl fisheries).

Considering the whole fishing season, the outcome of the drift-net fishery as reflected in the catch per effort was the same as in 1960 (3.3 tons). The total catch, however, dropped from 41,750 tons in 1960 to 35,660 tons in 1961, due to the persistent decline of the drift-net fleet.

B. Biological Data

Age and length compositions

Sampling in 1961 was carried out along the same general lines as in the preceding years and was restricted to some well defined fishing grounds. The fisheries, selected for sampling were in 1961:—

(1) *Fladen*, period: mainly July, area: north of 58°N, gear: herring trawl.
(2) *Dogger*, period: September/October, area: between 54°—55°N, 1°—2°E, gear: herring trawl.
(3) *Engelse Wal fishery* (Dutch counterpart of East Anglian fishery), period: October/November.
(4) *Sandettié fishery*, period: November, area: surroundings of Sandettié Bank, gear: herring trawl.
(5) *Channel fishery*, period: December, area: eastern part of English Channel, gear: herring trawl.

In the sampling programme market length measurements, on a fairly large scale were combined with a length/age analysis of a restricted number of small samples (50 herring).

The age compositions of the samples from the various fisheries are presented in Table 55, expressed as numbers per unit of effort. In Table 56, the mean length per age-group is shown and in Table 57, the length compositions. The material for the Fladen and 'Engelse Wal' fisheries comprise herring in all maturity stages; the data presented for the other fisheries refer to herring in maturity stage VI only.

Important features of the 1961 data were:—

(a) Recruitment to the Dogger spawning area was moderate, to the Fladen much lower than in the last few years, and to the Southern Bight fisheries extremely good, which is

Table 52. Catch and effort data of the herring trawl fishery in 1961

Top figures: total catch in tons.

Middle figures: effort in $\frac{\text{fishing hours}}{100}$ of a motor trawler of 500 BHP.

Bottom figures: catch per 100 hours' fishing.

Area	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
NE	662.3	1,934.5	1,282.1	1,204.3	233.2	17.8	—	307.6	243.3	1,665.5	1,106.7	302.1	8,959.2
	158.8	205.1	212.3	199.2	115.4	12.6	2.8	33.8	34.6	152.5	106.8	84.4	1,318.3
	4.2	9.4	6.0	6.0	2.0	1.4	—	9.1	7.0	10.9	10.4	3.6	6.8
NW	4.5	8.8	48.1	53.3	343.6	1,842.1	1,517.9	1,081.5	39.1	121.8	15.9	—	5,076.6
	2.6	1.8	17.1	8.5	81.1	95.7	66.7	45.3	1.2	8.7	1.3	—	329.9
	1.7	4.9	2.8	6.3	4.2	19.3	22.8	23.9	34.0	14.1	12.5	—	15.4
Central	—	0.3	54.4	11.7	84.7	1,655.2	6,979.9	11,433.6	13,099.3	3,046.6	67.3	9.9	36,442.9
	—	0.9	15.8	19.8	49.7	141.7	261.4	281.8	280.6	90.5	0.7	2.9	1,145.7
	—	0.3	3.4	0.6	1.7	11.7	26.7	40.6	46.7	33.7	100.5	3.5	31.8
South	—	—	22.7	—	—	—	—	—	124.5	—	3,339.1	5,907.0	9,393.3
	—	—	1.8	—	—	—	—	—	2.1	—	17.3	37.5	58.7
	—	—	12.4	—	—	—	—	—	59.9	—	193.1	157.6	160.1
SE Ireland .	510.1	0.4	—	3.5	—	—	—	66.8	224.1	649.0	633.3	860.8	2,947.9
	3.5	0.4	—	1.2	—	—	—	1.7	3.7	22.7	36.1	5.6	74.8
	147.9	1.0	—	3.0	—	—	—	39.7	61.2	28.6	17.5	154.0	39.4

Table 53. Catch of pair-trawl fishery in 1961

Total catch in tons

Area	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Central	—	8.7	0.5	—	—	23.6	35.6	6.8	269.2	974.5	—	—	1,318.9
South	1,622.3	189.1	—	—	—	—	—	—	—	285.3	6,707.9	3,585.4	12,390.0

Table 54. Catch and effort of drift-net fishery in 1961

Top figures: total catch in tons.

Middle figures: effort in number of shots.

Bottom figures: catch per shot in tons.

Area	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
NE	—	—	—	—	—	—	—	—	1.4	—	—	—	1.4
	—	—	—	—	—	—	—	—	2.0	—	—	—	2.0
	—	—	—	—	—	—	—	—	0.7	—	—	—	0.7
NW	—	—	—	—	414.5	1,217.2	294.1	6,920.9	745.5	0.7	—	—	9,593.0
	—	—	—	—	478	986	123	1,378	288	1	—	—	3,254
	—	—	—	—	0.9	1.2	2.4	5.0	2.6	0.7	—	—	2.9
Central	—	—	—	—	6.1	1,788.1	3,053.9	605.3	3,181.0	2,197.8	—	—	10,832.2
	—	—	—	—	8	1,076	1,856	292	1,212	807	—	—	5,251
	—	—	—	—	0.8	1.7	1.6	2.1	2.6	2.7	—	—	2.1
South	—	—	—	—	—	—	—	—	—	6,615.9	8,259.1	359.2	15,234.2
	—	—	—	—	—	—	—	—	—	746	1,368	69	2,183
	—	—	—	—	—	—	—	—	—	8.9	6.0	5.2	7.0

Table 55. Age compositions, expressed in numbers (thousands) caught per unit of effort[1])

Area	Age in years 2	3	4	5	6	7	8	9	10	>10	Maturity
Fladen	—	8.7	28.5	65.3	5.1	4.6	1.3	3.0	0.4	0.4	All maturity stages
Dogger	—	8.1	0.8	14.4	1.4	0.5	0.2	0.3	0.05	0.03	Stage VI only
'Engelse Wal' ..	0.7	42.8	5.7	2.0	0.1	0.1	—	—	—	—	All maturity stages
Sandettié		37.1	10.8	5.8	0.9	0.5	0.06	0.03	—	0.03	Stage VI only
Channel		39.8	6.8	4.2	0.2	0.4	0.06	0.02	—	—	Stage VI only

[1]) The units of effort used for the various areas are:

Fladen: 100 hours fishing of a trawler of 500 BHP
Dogger: a day fishing (12 hours) of a trawler of 500 BHP
Engelse Wal: numbers per shot of a drifter.
Sandettié: a day fishing (4 hours) of a trawler of 500 BHP
Channel: a day fishing (4 hours) of a trawler of 500 BHP

Table 56. Mean length per age, for various areas

Area	Age in years 2	3	4	5	6	7	8	9	10	Maturity
Fladen	—	26.2	26.9	27.6	28.9	29.4	30.0	29.7	31.1	All maturity stages
Dogger	—	25.7	27.1	27.5	28.7	29.4	29.3	30.3	29.7	Stage VI
'Engelse Wal' ..	22.1	24.4	26.3	27.3	28.3	28.4	—	—	—	All maturity stages
Sandettié	—	24.5	26.1	27.0	28.2	28.9	29.0	30.2	—	Stage VI
Channel	—	24.3	26.1	26.9	28.2	28.9	28.5	29.0	—	Stage VI

Table 57. Percentage length compositions on various fishing grounds

Area	Length (nearest cm) (%) 21	22	23	24	25	26	27	28	29	30	31	32	Maturity
Fladen	—	—	0.1	0.7	2.6	14.8	32.3	27.6	15.5	4.6	1.4	0.3	All maturity stages
Dogger	—	—	0.4	3.6	9.0	18.6	30.9	23.9	9.5	3.0	0.9	0.2	Stage VI
'Engelse Wal'	0.5	4.6	15.9	26.5	24.0	17.0	8.9	2.3	0.3	0.1	—	—	All maturity stages
Sandettié	—	1.7	10.6	23.1	25.4	20.5	12.2	5.1	1.3	0.2	—	—	Stage VI
Channel	0.4	2.8	14.7	27.4	25.4	16.2	8.6	3.2	0.8	0.1	—	—	Stage VI

probably the cause of the success of the fisheries in this area.

(b) The 3 year-old fish were large on all grounds. Their average length was among the highest on record, together with the length of the 3 year-old fish in the period 1952/1955.

(c) Herring of the 1956 year-class still predominated in the catches of the Dogger and Fladen fisheries.

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Table 58. Midwater trawlers: number of trawlers, number of trips and fishing effort

Months	Number of trawlers	Number of trips	Fishing effort (V × h.p.)
October	18	17	6,900
November	22	133	51,008
December	20	79	31,340
January	8	13	3,832
Total 1961/62 ..	22	242	93,080
Total 1960/61 ..	25	256	104,560

The Belgian Herring Season 1961/1962

(Figure 10; Tables 58–70)

A. The Fishery

The herring fishery was carried out in the sector Sandettié covering an area from the Scheldt Estuary to the eastern part of the English Channel. Only the pelagic trawl, towed by two trawlers fishing together, was used during this season.

With the exception of two coastal trawlers fishing together with midwater trawlers, the herring fishery was exclusively carried out by midwater trawlers in the sector Sandettié.

Owing to the scarcity of sprat, about forty coastal trawlers switched over to the herring fishery. The area where these coastal trawlers were active limited itself to the coastal waters, whereas the midwater trawlers were active further afield.

The coastal trawlers used the pelagic sprat trawl, also towed by two trawlers fishing together. The dimensions as well as the meshes of the pelagic sprat trawl are much smaller than those of the ordinary pelagic herring trawl, so that a comparison

Table 59. Midwater trawlers: yields and average catches

Months	Yields of herring (tons)	Incidental catches (tons)	Total (tons)	Average catch per trip (tons)	Average catch per V x h.p. (kg)
October	109.4	0.1	109.5	6.4	16
November	1,483.3	37.3	1,520.6	11.2	29
December	781.3	27.9	809.2	9.9	25
January	103.3	2.7	106.0	7.9	27
Total 1961/62	2,477.3	68.0	2,545.3	10.2	27
Total 1960/61	2,508.2	201.4	2,709.6	9.8	24

Table 60. Coastal trawlers: number of trawlers, number of trips and fishing effort

Months	Number of trawlers	Number of trips	Fishing effort (V × h.p.)
November	18	40	6,520
December	36	56	8,046
January	4	4	660
Total 1961/62	41	100	15,226

of the results obtained by the midwater and coastal trawlers respectively cannot be made.

For this reason the results obtained by the two types of trawlers are given separately.

I. Midwater trawlers

The first catches were landed on 24. October 1961 and the last on 10. January 1962. The trawlers were mostly active on the Thornton Ridge, the Hinders and Fairy Banks, in the vicinity of the Sandettié L.V. and on Snow Bank.

Tables 58 and 59 give records of the fishing effort and the yield of the fishery. Twenty-two trawlers made 242 trips and developed 93,080 V × h.p. (V = voyages). The corresponding figures for 1960/61 were: 25 trawlers, 256 trips and 104,560 V × h.p. (Table 58).

A total weight of 2,545.3 tons was landed of which 2,477.3 tons were herring (97.3%) and 68.0 tons incidental catches (2.7%). The average catch per trip reached 10.2 tons and per V × h.p. 27 kg (Table 59).

For the previous season, these figures were 2,508.2 tons of herring, the average catch per trip being 9.8 tons and per V × h.p. 24 kg.

II. Coastal trawlers

The first catches were landed on 6. November 1961 and the last on 6. January 1962. The fishery took place in the coastal waters off the Belgian Coast between Nieuport and Dunkirk.

Tables 60 and 61 give records of the fishing effort and the yield of the fishery. Forty-one trawlers made 100 trips and developed 15,226 V × h.p. (Table 60).

A total weight of 381.6 tons was landed of which 359.2 tons were herring (94.1%) and 22.4 tons incidental catches (5.9%). The average catch per trip reached 3.6 tons and per V × h.p. 24 kg (Table 61).

Table 62. Length, weight and sex (‰)

cm	Nov.	Dec.	Jan.	Total 1961/62	Total 1960/61
30	2	—	—	1	1
29	2	—	—	1	1
28	22	13	20	18	13
27	83	47	60	65	47
26	119	140	110	127	137
25	207	235	170	215	**279**
24	**305**	**332**	**270**	**313**	258
23	200	195	**270**	206	159
22	55	35	90	50	54
21	5	3	10	4	37
<21	—	—	—	—	14
Total	1000	1000	1000	1000	1000
Average length, mm	249	249	246	249	248
Mode, cm	24	24	23/24	24	25
Weight, g	118	103	95	109	112
Males ‰	493	476	400	476	485

B. Biological Data

A total of 920 herrings were analysed; they were collected from catches made in the southern North Sea by trawlers using the pelagic trawl

Table 61. Coastal trawlers: yields and average catches

Months	Yields of herring (tons)	Incidental catches (tons)	Total (tons)	Average catch per trip (tons)	Average catch per V x h.p. (kg)
November	154.0	16.6	170.6	3.9	24
December	189.7	5.7	195.4	3.4	24
January	15.5	0.1	15.6	3.9	23
Total 1961/62	359.2	22.4	381.6	3.6	24

Table 63. Stages of maturity (‰)

Stages	Nov.	Dec.	Jan.	Total 1961/62	Total 1960/61
I	14	2	—	8	18
II	14	8	—	10	18
III	—	—	—	—	—
IV	21	—	—	10	7
V	**398**	2	—	183	145
VI	148	25	10	79	276
VII	29	10	20	19	15
VIII/II	376	**953**	**970**	**691**	**521**
Total	1000	1000	1000	1000	1000

Table 64. Quantity of intestinal fat (‰)

Quantity	Nov.	Dec.	Jan.	Total 1961/62	Total 1960/61
0	252	335	350	258	200
1	**636**	**627**	**640**	**553**	**747**
+	98	28	10	158	23
M	14	10	—	31	30
Total	1000	1000	1000	1000	1000
Index	2.14	1.71	1.66	1.96	1.88

Table 65. Quantity of intestinal fat according to the stages of maturity (‰)

Quantity	Stages of maturity I	II	IV	V	VI	VII + VIII/II
0	—	—	—	—	247	335
1	—	—	**556**	226	**753**	**628**
+	285	**556**	444	**661**	—	35
M	**715**	444	—	113	—	2
Total	1000	1000	1000	1000	1000	1000
Index	3.75	3.44	2.44	2.89	1.75	1.70

Table 66. Age (‰)

Age	Year-class	Nov.	Dec.	Jan.	Total 1961/62	Total 1960/61
2	1959	4	9	—	6	15
3	1958	**551**	**621**	**644**	**597**	**562**
4	1957	300	289	241	287	371
5	1956	118	78	103	97	33
6	1955	11	3	—	6	15
7	1954	8	—	12	4	3
8	1953	8	—	—	3	—
+8	<1953	—	—	—	—	1
Total		1000	1000	1000	1000	1000
Average age (years, months)		3.8	3.5	3.6	3.6	3.6

Table 67. Average lengths by age and value of L_1 (mm)

Average length by age (mm) Year-class	Season 1961/62	Season 1960/61	Average value of L_1 (mm) L_1	Season 1961/62	Season 1960/61
1959	226	—	1959	150	—
1958	241	218	1958	121	147
1957	258	239	1957	118	127
1956	272	258	1956	115	117
1955	276	272	1955	132	124
1954	283	277	1954	116	119
1953	295	283	1953	107	118

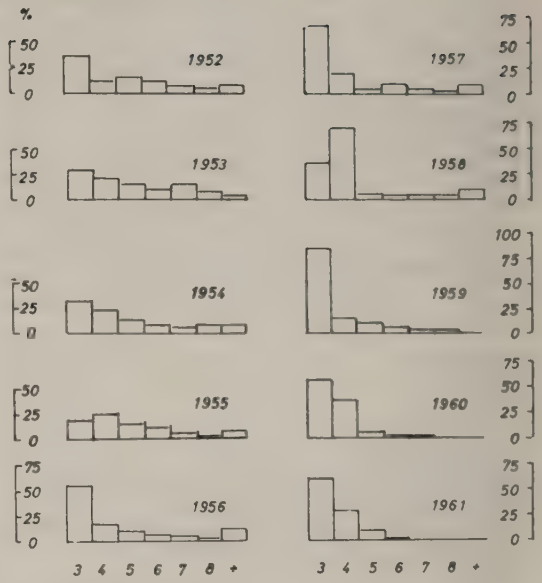

Figure 10. Age compositions of the herring concentrations exploited by the Belgian trawlers in the Sandettié area during the period 1952/1961.

Table 68. Vertebrae, Vert. S. (‰)

Vert. S.	Nov.	Dec.	Jan.	Total 1961/62	Total 1960/61
59	—	—	—	—	1
58	75	73	72	74	54
57	**478**	**524**	**612**	**513**	**503**
56	403	382	306	383	405
55	41	18	10	28	35
54	—	3	—	1	2
53	3	—	—	1	—
Total	1000	1000	1000	1000	1000
Average	56.580	56.648	56.745	56.628	56.575

(Sandettié area) — 420 in November and 420 in December 1961, and 100 in January 1962.

Table 62 shows the length distribution of the herring in each month. The average weight, the per mille number of males and the average length of the fish are also recorded.

Table 63 gives the stages of maturity in each month. As in previous years the quantity of intestinal fat was estimated. The results are shown in Table 64. The quantity of intestinal fat was also estimated according to the stages of maturity (Table 65).

The age compositions of the catches in 1961/62 are shown in Table 66 and those for each year since 1951 are given in Figure 10. 3 year-old fish were predominant during each of the three months.

The average length of the herring and the

growth-rate during the first year (L_1) are given in Table 67.

The number of vertebrae observed per spine varies between 53 and 58 (Table 68). The spines with 57 vertebrae predominate. The average number of vertebrae according to the year-classes is given in Table 69.

Finally, Table 70 gives the number of keeled scales (K_2) for the three months.

Only 1 stomach was found to contain food.

C. Conclusions

Once more, the 3 and 4 year-old herring made up the majority of the catches. These two young year-classes (1958 and 1957) constituted 88.4% of the total samples.

A marked difference has been observed between the vertebral average of the one and two year-old herring and the average of the three year-old and older herring. The average number of vertebrae of the first group is estimated at 56.535 and for the second group at 56.609. This difference is presumably due to a mixture of two characteristic populations in the Sandettié area.

During the course of the season, a marked increase in the average number of vertebrae was observed: 56.580 in November, 56.648 in December and 56.745 in January. It is the first time that such high averages have been recorded in the Sandettié area. This probably indicates a fairly large penetration of Channel herring into this area.

Table 69. Average number of vertebrae according to the year-classes

Year-class	Season 1961/62	Season 1960/61
1953	56.000	56.500
1954	57.000	56.636
1955	56.500	56.231
1956	56.692	56.547
1957	56.585	56.613
1958	56.652	56.333
1959	56.000	—

Table 70. Keeled scales (K_2) in ‰

K_2	Nov.	Dec.	Jan.	Total 1961/62	Total 1960/61
19	2	—	—	1	—
18	5	5	10	6	2
17	29	13	20	21	21
16	168	133	81	143	160
15	**499**	**470**	**526**	**490**	**470**
14	264	338	333	303	291
13	31	41	20	34	54
12	2	—	10	2	2
Total	1000	1000	1000	1000	1000
Average	14.916	14.754	14.747	14.828	14.803

The absence of older herring in the commercial catches has always been considered to be of ill omen for the success of the future herring seasons.

Up to the present this has always been the case and so the prospects for the coming herring season are accordingly once more rather unpromising.

CH. GILIS

C. Skagerak, Kattegat, and Baltic-Belt Seas

Young Stages

Young Herring for Fish Meal, etc. in the Limfjord, Skagerak Kattegat and Baltic-Belt Seas in 1961

(Table 71)

Limfjord

The 0- and I-group herring caught in March in different parts of the fjord were Limfjord spring spawners (see Table 71). In October, 0-group North Sea autumn spawners from the Dogger Bank region were caught in Nissum Broad and in Venø Bay (the next broad in the fjord), and the same herring, mixed with Limfjord spring spawners, constituted the catches from the central Limfjord in October/November.

Skagerak and northern Kattegat

0-group herring were relatively scarce in the catches during the first half of 1961. I-group fish of 12—17 cm length caught in January/April were Kattegat winter herring, and those of 15—24 cm in a catch taken on 20. March, and of 17—27 cm taken on 7. August, with 1 and 2 rings, were of the same race (Table 71).

On the other hand, those over 17 cm in 4 samples from January/April were pure North Sea autumn spawners of the Dogger Bank tribe. Those of 16—23 cm length, and with 1 and 2 rings, caught at Læsø in pound nets on 9. April were also Dogger Bank herring. They were in a very bad state

Table 71. Length and racial characters of young herring caught in the Limfjord, Skagerak, Kattegat, Belts and Baltic

Date	Depth, m	Number of samples	Range, cm	Vert. S. Mean	Vert. S. Number	Vert. P. Mean	K_2 Mean	K_2 Number
			The Limfjord					
7. March	25	3	10–15	55.85	128	23.58	14.27	101
7. March	25	3	16–21	55.76	306	23.65	14.08	303
29./30. Oct.	6	2	8–13	56.34	206	23.80	14.65	184
Oct./Nov.	6–25	4	8–13	56.16	384	23.86	14.38	273
			Eastern Skagerak – Northern Kattegat					
Jan./Apr.	47–85	5	12–17	56.93	273	24.20	14.36	102
Jan./Apr.	68–98	4	17–24	56.52	201	24.01	14.67	126
20. March	57	1	15–24	56.81	144	24.22	14.33	132
9. April	4	1	16–23	56.37	156	24.08	14.53	47
7. August	115	1	17–27	56.71	75	24.11	14.12	43
June/Dec.	4–115	13	5–17	56.42	1531	23.79	14.62	1184
			Aarhus Bay (northern Belts)					
Jan./Feb.	24–38	2	9–17	56.02	222	23.70	14.13	236
Nov./Dec.	14–24	5	9–18	56.21	713	24.41	14.47	543
			Great Belt					
14. August	14	1	10–12	56.35	164	24.20	—	—
			Little Belt					
Jan./Feb.	32–38	2	9–11/12	55.49	100	24.11	13.74	86
Jan./Feb.	32–38	—	12/13–18	55.13	220	23.81	14.09	175
			Baltic, at Bornholm					
2. March	—	1	9–12	55.61	61	23.61	14.00	29
2. March	—	1	13–18	55.90	167	24.22	14.41	100

when investigated, and the K_2 shown in Table 71 is probably a little too low.

In June, a new year-class of North Sea autumn spawners from the Dogger Bank region were found in enormous quantities along the Kattegat coast of northern Jutland. They dominated the catches for the rest of the year. Their average lengths in the catches in June, were about 8 cm but the real mean for the stock must have been somewhat less. In August, the mean length was about 11 cm and in October/November 13—15 cm. From August they were mostly fished by trawl in 30—100 m depth in the open sea.

The Belts

Two samples from Aarhus Bay (northern Belts) in January/February consisting of herring of 14—15 cm in length were young local spring spawners, but those in 5 samples, taken in November/December, of herring about 13—14 cm were young autumn spawners from the Belts, mixed with Kobbergrund herring.

In a sample from south-east of Fyn in the Great Belt on 14. August, the Vert. S. count was that of the Kobbergrund but the Vert.P. was a little lower than in this race. They may have been mixed with some low Vert.P. autumn spawners, most likely Dogger Bank herring, which were found in the northern Kattegat in very great quantities. It may be remembered that young North Sea autumn spawners from the Dogger Bank have been found in the Belts in a previous year (1958).

Herring of 9—18 cm length caught between Als and Fyn in the Little Belt in January/February were analysed. The smaller ones were unmixed autumn spawners from the Belts, whereas the larger ones were mixed with Kattegat coastal autumn spawners, or Kobbergrund herring.

At Bornholm, the smaller members of a sample 9—18 cm in length, caught on 2. March were unmixed central Baltic spring spawners, but the larger ones were mixtures of these and Kattegat autumn herring, either coastal spawners or Kobbergrund herring.

Aa. J. C. Jensen

Adult, Commercial Fish

Herring for Consumption in Danish Catches from the North-Eastern North Sea, Skagerak, Kattegat, Belts and Baltic in 1960 and 1961

(Table 72)

North-eastern North Sea

A considerable Danish herring fishery has developed during recent years off Egersund, Stavanger and Haugesund over and at the western edge of the Norwegian Channel.

In a sample from February 1960 (see Table 72) about 90% of the herring were in maturity stages II, VII and VIII, and of nearly the same length. No doubt most of those in maturity stage II had spawned before; in many cases it is difficult to distinguish between maturity stages VIII and II. Some 6% were in maturity stage I and of about 22 cm length, and 5 specimens were in maturities IV—VI. Those in maturity stages II, VII and VIII had identical racial characters. From Table 72 it is seen that the herring of maturity stages II, III, VII and VIII in two samples from November 1960 had the same racial characteis. Also in these samples a few herring were of maturity stage I and of about 22 cm in length, and a few were of maturities IV—VI.

The immature herring in the two samples from the Viking Bank in February 1961, and from west of Haugesund in March (Table 72) had the same racial characters.

It is noteworthy that the characters found here are not represented in the basic diagrams given in Rapp. Cons. Explor. Mer, **143** (2): 96—97, 1958, in which all known combinations of the three racial characters in herring fished in maturity stages V—VI up to that year are shown. However, many samples of young herring from the Skagerak show the same combinations. I have been inclined to suppose that these were mixtures of young Kattegat or Belt Sea coastal spring spawners and young of the Atlanto-Scandian type, but such a mixture can hardly be found off SW Norway. Therefore they must belong to an 'unknown race', identical or closely related to the North Sea, deep water herring spawning in October/November on the Viking Bank and Tampen Bank in about 200 m depth, and investigated by H. Brock ("Norwegische Heringsuntersuchungen während der Jahre 1904—1906". Bergens Mus. Aarb. 1908, No. 1). I had not previously included them in the basic diagrams on account of the small numbers investigated. From samples of unmixed spawning herring, the racial characters of the deep water herring are: Vert. S., 56.64; Vert.P., 23.64; K-, 14.41 (98 specimens). The spents and recovering spents in a sample from the Viking Bank are North Sea deep water herring mixed with Fladen Ground autumn spawners (Shetland-Scottish in the basic diagrams), and those from off Haugesund are North Sea deep water herring mixed with some of the Atlanto-Scandian type.

Skagerak, northern and central Kattegat

In the Skagerak, relatively few adult herring have been caught by Danish fishermen in recent years. In a sample from NW of the Scaw on 5. October, the immatures, which constituted the major part of the catch were Kattegat winter spawners, and the few in maturity stages IV—V seem to have been of the same race, but very much nearer to the autumn spawners of the North Sea. The same was the case with the immatures in a sample from east of Læsø in November (Table 72). The spent herring in this catch were large, coastal, autumn spawners from the Kattegat. A catch from north of Læsø in November consisted largely of immatures, of about 23 cm but a fifth were spents of about 24 and 27 cm; all were typical Kobbergrund herring.

A sample of trawl caught herring from east of Læsø, on the Kobbergrund, on 27. January 1961 (Table 72) was a mixture of all maturities. The few immatures, of 21—27 cm length, were mostly 2-ringed and they also seem to have been Kobbergrund herring. The few maturing herring were North Sea autumn spawners, and the spawning and spents were Kattegat/Skagerak winter spawners, but, as is often the case, with a relatively high K_2. A catch of immature herring of 19—27 cm from NW of the Scaw on 28. February were of the same racial group, but those of about the same length with lower values, caught on 20. March off Hirtshals, were Downs herring mixed a little with the winter spawners.

A sample from Grebbestad, Bohuslän consisting largely of mature herring, of one of the tribes belonging to the Atlanto-Scandian group was kindly sent me by Dr. Höglund. The data given provide the first full statement of the racial characters of this tribe, and it shows that they are very similar to those of the Minch and Clyde herring and also to those of the southern type of Norwegian winter spawners, with a relatively low vertebral count.

Table 72. Lengths and racial characters of herring for human consumption caught in the north-eastern North Sea, Limfjord, Skagerak, Kattegat, Belts and Baltic

Locality	Depth, m	Gear	Date and year	Maturity stage	Length, cm Mean	Range	Vert. S.	Number	Vert. P.	K_2	Number
				Off SW Norway							
W of Haugesund .	200	M	15. II. 60	I, II, VII, VIII	25	21–30	56.53	173	23.51	14.32	173
SW of Stavanger .	150	M	18. XI. 60	II, III, VII, VIII	27	23–33	56.54	160	23.64	14.35	159
WSW of Stavanger	230	M	29. XI. 60	III–V	29	25–32	56.88	25	24.28	13.68	25
				VII, VIII	28	24–31	56.51	117	23.43	14.63	117
Viking Bank	260	M	18. II. 61	I, II, III	26	21–31	56.57	127	23.63	14.26	124
				VII, VIII	28	23–32	56.51	105	23.54	14.61	104
W of Haugesund .	250	M	1.–4. III. 61	II	27	24–30	56.53	99	23.58	14.28	98
				VII, VIII	28	25–31	56.77	77	23.64	14.53	77
				The Limfjord							
Livø Broad	9	T	21. XI. 60	III, IV	24	20–27	56.01	155	23.68	14.31	155
				Eastern Skagerak, Northern and Central Kattegat							
At Kobbergrund ..	70	T	27. I. 61	I, II, III	23	21–27	56.14	21	24.32	14.25	20
				IV, V	26	23–29	56.43	23	23.62	14.61	28
				VI–VIII	27	23–34	57.01	48	24.64	14.77	48
NW of Scaw and off Hirthsals ...	50–110	T	28. II. & 20. III. 61	I, II	23	17–27	56.78	316	24.21	14.39	295
NW of Scaw	100	T	20. II. 61	I, II	23	19–25	56.52	23	24.13	14.87	24
Grebbestad	—	P	14. III. 61	IV–VII	26	22–33	57.09	193	24.50	14.10	192
NW of Hirthals ..	115	T	7. VIII. 61	I–III	19	17–27	56.71	45	24.11	14.12	43
NNE of Scaw	185	T	19. IX. 61	I	22	18–27	57.03	102	24.22	14.70	97
				II, III	25	20–28	56.71	84	24.17	14.40	82
				IV–VI	26	22–29	56.33	39	24.38	14.42	38
At Kobbergrund ..	75	T	24. IX. 61 16. X. 61	IV–VIII	28	22–33	56.24	387	24.77	14.42	385
				Southern Kattegat, Belts and Baltic							
Entrance to the Sound	30	T	10. I. 61	I–IV	22	19–25	55.89	154	24.05	14.13	151
At Hundested	—	P	21. IV. 60	V–VIII	26	21–29	56.18	157	23.67	14.11	156
Isefjord	—	P	25. IV. 60	I–III	22	18–24	55.97	35	23.49	14.17	47
				IV–VIII	23	19–27	56.03	159	23.45	13.96	158
At Hundested	—	P	23. V. 61	I, II	24	19–27	55.95	75	23.75	14.16	74
				V–VIII	24	21–27	55.88	98	23.63	14.11	97
Entrance to Belts .	25	D	3. X. 60	III–VIII	28	22–33	55.94	112	24.70	14.32	107
N of Hundested ..	25	T	17. X. 60	II–V	22	19–28	56.11	150	23.86	14.20	147
Entrance to Belts .	25	D	5.–16. X. 61	IV–VIII	28	23–32	56.14	187	24.78	14.41	187
At Hundested	—	P	11. X. 61	I–III	25	22–28	55.71	58	24.30	14.02	58
				IV–VIII	25	21–28	55.91	104	24.35	14.37	102
E of Bornholm ...	60	T	13. IX. 60	I–IV	20	17–26	55.48	127	23.91	13.67	122
				V–VIII	23	17–26	55.51	114	23.84	14.13	113

Immature herring of 17—27 cm (mostly 22—25 cm) caught on 7. August, off Hirtshals were Kattegat winter spawners. In a sample of similar length, caught on 19. September, NNE of the Scaw, the fish in maturity stages II—III were of the same tribe, whereas those in maturity stage I may be mainly Bohuslän spring herring of the Atlanto-Scandian type, but mixed with some other race. A few, maturing herring in this sample were Kobbergrund herring, as were almost all of those caught on the Kobbergrund on the 24. September and 16. October.

As in recent years, Kattegat winter spawners constituted the greater part of the catches, whereas North Sea autumn spawners were relatively scarce.

Limfjord

A sample of herring 20—27 cm long, caught by trawl in November 1960 from the Livø Broad consisted mostly of 2-ringed herring in maturity stages III and IV. The data given in Table 72, also include a few immature and almost mature herring. These have the racial characters of the Kattegat (or Belts) coastal spring spawners with a high vertebral count. They have never before been observed in the Limfjord. However, it is possible that the racial characters might be due to a mixture of about equal parts of Limfjord spring spawners and North Sea autumn spawners. Immatures of both these races are regularly found in the fjord, but the 2-ringed North Sea autumn

spawners should be somewhat larger than the 2-ringed Limfjord spring spawners. The herring were nearly all 23—24 cm in length and the very narrow range of length therefore indicates that the herring were unmixed.

Southern Kattegat and the Belts

At the northern entrance to the Sound an extraordinarily large trawl fishery for herring took place in the first months of the year. It is seen from the racial characters shown in Table 72 that they were Belt Sea autumn herring.

During the normal pound net fishery for coastal spring spawners at North Seeland, two catches were investigated in April 1960 and one in May 1961. From Table 72 it is seen that, in the 1960 samples, large coastal spring spawners of the Kattegat were fished off the open coast, but in the Isefjord it was the smaller southern Kattegat and northern Belts spring spawners. Previously these have often spawned off the open coast of the Kattegat. They occurred there in the May sample in 1961, where they were found both as mature and immature fish.

In October 1960, a drift-net sample from the northern entrance to the Belts consisted of southern Kattegat coastal autumn spawners, and in October 1961 the same race was found in a pound net sample from North Seeland. However, a drift-net sample from the spawning grounds between the Kattegat and the Belt Sea in October 1961, gave catches of an unusual large spawning herring for this region. They were the large Kattegat coastal autumn herring, which is closely related to the Kobbergrund herring. It has also been found spawning here in some previous years. Kattegat spring spawners, but mostly immatures, were caught by trawl in the southern Kattegat, north of Hundested, in October 1960 (Table 72).

The central Baltic

From the autumn herring fishery at Bornholm, a sample in September, consisted partly of immature and partly of maturing herring, some of which were ready for spawning and some were spawning or spent. They had the normal racial characters of the Bornholm autumn spawners, in which the K_2 may vary rather much from one year-class to another (see the basic diagrams (1958) and Table 72).

Aa. J. C. Jensen

Polish Investigations of Baltic Herring in 1961

(Table 73)

The age and length compositions of the spring spawning Baltic herring during the summer/autumn feeding period are presented in Table 73.

As in 1960, the most numerous year-classes in both the Bornholm and Gdansk regions were those of 1954, 1955 and 1957. The landings of Baltic herring were approximately the same as in 1960.

The length/weight coefficient (maturity stages II—III) in the spring spawning herring decreased slightly in 1961; in the Gdansk region from 0.638 in 1960 to 0.629 in 1961, and in the Bornholm Basin from 0.648 in 1960 to 0.641.

J. Popiel

Table 73. Length and age distributions of Baltic herring in 1961 (‰)

Length

cm	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Nos.
Gdansk region	1	16	68	127	151	182	156	97	66	61	46	17	7	3	1	1	4,348
Bornholm Basin ..	3	14	40	92	133	183	171	147	72	53	58	21	10	3	—	—	3,143

Age

Age	2	3	4	5	6	7	8	9	10	11	12+	Nos.
Year-classes	1960	1959	1958	1957	1956	1955	1954	1953	1952	1951		
Gdansk region	4	30	47	197	71	270	177	68	60	40	36	504
Bornholm Basin ..	26	97	57	167	27	294	134	101	45	34	18	400

Sardine

Sprat

Tagging Experiments on Sprat in Norwegian Waters

Taggings of sprat were continued in the fjords of western Norway during 1961.

In the period 19. May — 27. June 1961, 1093 sprat were tagged externally at Lundegrend in the Bjørnefjord area. Of this quantity 245 tags were recovered after having been at liberty 10—30 days.

Most of the sprat tagged at Lundegrend spread to the Bjørnefjord area but some recaptures came also from Seløysund, Høylandssund and Skånevikfjord in Sunnhordland.

At Ims in the Ryfylkefjord, 1721 sprat were tagged externally during the period 7. — 15. June 1961. Of this quantity 127 were recaptured having been at liberty from 1 to 77 days. The majority of the recaptures came from places close to the tagging locality.

At Onarheim in Sunnhordland 1079 sprat were tagged externally during the period 8.—23. June 1961. The result of this tagging experiment was 56 recaptures. Most of the recaptures are from localities close to the tagging place, only a few were taken miles away further into the Hardangerfjord. Recaptures were made from 2 to 83 days after tagging.

During the period 26. July — 25. August, 1227 sprat were tagged externally at Øystese in the Hardangerfjord. Of this quantity 53 were recaptured, after 1 to 19 days at liberty. The majority of the recaptures came from places near Øystese, only a small quantity came from places further into the Hardangerfjord.

In the period 29. August — 8. September, 843 sprat were tagged internally at Øystese. This tagging experiment has given no recaptures up to the present.

The first recapture of tagged sprat which had been nearly a year at liberty was made in 1961. An internally tagged sprat tagged at Aksnes in the Hardangerfjord on 7. September 1960 was recaptured 10. June 1961 at Gangdal, about 7 nautical miles further out the fjord.

KAARE R. GUNDERSEN

Scombriform Fish

Mackerel

The Mackerel Fishery in the North Sea of the Netherlands in 1961

(Tables 1–2)

The fishery

The total catch amounted to 20,328 tons (1960 = 21,487 tons) and remained at a high level. The area NE produced the largest part of the landings, here the fishery was successful from May until November with high catches especially in April and September. In the area NN the mackerel density was very much less than in the previous year, consequently the catches and fishing effort in that region dropped to the normal level. The heavy fishing effort during summer and autumn in the southern area was caused by a good fishery for herring in that area, while during the same time in the area NW, by absence of good herring concentrations, the fishing effort was lower than normal.

The length distribution

The length distribution of the fish caught in the area NE, showed during the whole period a mode shifting from 33 cm and 34 cm during the first quarter, to 34 cm, 35 cm and 36 cm during the fourth quarter of the year. The same mode is to be observed in other areas' shifting in the same way; however, during the first quarter of the year, the mackerel of 28, 29 and 30 cm were more numerous in the areas NW and S.

As so far as it is possible to draw conclusions

Table 1. Total catch, effort and catch per effort per month in four fishing areas during 1961

1961	Total catch in tons					Number of hours fishing, trawl 500 BHP					Catch in kg per 100 hours fishing, trawl 500 BHP			
	NN	NE	NW	S	Total	NN	NE	NW	S	Total	NN	NE	NW	S
January	197.2	304.6	—	—	501.8	6,420	9,655	—	—	16,075	3,071	3,154	—	—
February	198.0	374.9	—	—	572.9	7,874	12,820	—	—	20,694	2,514	2,924	—	—
March ...	370.4	454.2	—	15.5	840.1	14,357	8,622	—	1,300	24,279	2,578	5,267	—	1,192
April	777.6	3,393.8	—	—	4,171.4	5,191	16,254	—	—	21,445	14,979	20,879	—	—
May	764.4	1,926.9	300.8	129.0	3,121.1	8,577	12,350	2,344	1,346	24,617	8,912	15,602	12,832	9,580
June	—	593.3	—	1,086.7	1,680.0	—	3,917	—	19,370	23,287	—	15,543	—	5,610
July	—	258.3	261.9	972.3	1,492.5	—	1,386	5,740	22,594	29,720	—	18,636	4,562	4,303
August ..	—	953.3	743.6	1,335.6	3,032.5	—	2,780	3,538	28,184	34,502	—	34,291	21,017	4,738
Sept.	—	2,177.7	—	188.3	2,366.0	—	6,890	—	24,954	31,844	—	31,606	—	754
October .	123.2	2,145.4	—	—	2,268.6	1,908	14,494	—	—	16,402	6,457	14,801	—	—
November	178.5	80.1	—	—	258.6	8,154	2,648	—	—	10,802	2,189	3,025	—	—
December	16.7	6.3	—	—	23.0	5,985	2,458	—	—	8,443	279	256	—	—
Total ...	2,626.0	12,668.8	1,306.3	3,727.4	20,328.5	58,466	94,274	11,622	97,748	262,110	—	—	—	—

Table 2. Percentage length distributions of the catch in the different areas during the quarters of the year

1961	NN				NE				NW				S			
Length, cm	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
23	—	—	—	—	—	0.1	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	0.2	—	—	—	0.4	—	—	—	—	—	—	—
25	—	—	—	—	—	0.1	—	—	0.4	—	—	—	—	—	—	—
26	0.2	—	—	—	0.3	0.1	—	—	—	—	—	—	0.6	—	—	—
27	1.6	—	—	0.1	3.2	1.6	—	—	5.4	0.8	—	—	3.4	—	—	—
28	3.1	2.0	—	—	8.3	4.1	0.1	—	10.5	1.4	—	—	13.5	0.6	0.1	—
29	4.1	2.7	—	0.4	8.2	5.9	0.1	1.0	11.6	0.8	—	—	13.6	1.8	0.8	—
30	4.9	3.7	—	1.7	11.2	8.6	0.4	0.2	10.8	3.1	0.1	—	12.7	5.2	4.7	—
31	3.3	3.5	2.1	7.5	7.4	6.9	2.0	2.4	5.0	3.6	0.1	—	10.1	5.9	12.7	—
32	3.8	4.7	2.2	9.8	7.4	8.2	5.6	8.2	0.7	3.7	0.2	—	7.3	6.9	12.2	—
33	11.1	14.1	12.6	6.2	13.0	18.2	15.1	10.2	8.9	21.1	5.5	—	12.4	11.0	12.0	—
34	9.5	16.8	18.4	5.0	10.7	18.3	29.9	16.3	11.0	21.0	18.4	—	9.4	15.7	16.8	—
35	10.4	11.4	19.0	8.9	7.8	9.9	23.0	17.4	8.8	18.9	21.6	—	5.3	14.9	14.4	—
36	11.4	12.6	13.5	11.9	7.1	9.3	12.3	14.5	7.1	7.5	24.5	—	3.7	13.3	12.1	—
37	15.2	9.8	12.1	15.6	7.3	6.2	6.6	11.1	10.6	10.5	20.3	—	6.7	13.5	8.6	—
38	9.1	5.5	7.9	15.5	3.5	0.7	3.7	7.1	7.1	3.1	7.4	—	—	7.6	3.3	—
39	6.1	5.5	6.1	6.9	1.7	1.1	0.8	4.1	1.8	3.9	1.6	—	—	2.3	1.1	—
40	2.7	4.3	2.6	6.4	0.7	0.4	0.3	3.3	—	0.7	0.2	—	—	0.6	0.3	—
41	1.5	1.9	1.3	2.5	1.0	0.4	0.1	2.4	—	—	0.1	—	0.6	0.4	0.5	—
42	1.1	0.8	1.6	—	0.6	0.2	0.1	1.7	—	—	—	—	—	0.3	0.2	—
43	0.5	0.4	0.5	0.4	0.3	0.1	—	0.8	—	—	—	—	0.6	—	0.1	—
44	—	—	—	—	0.1	—	—	0.2	—	—	—	—	—	—	—	—
45	0.1	—	—	—	—	—	—	0.1	—	—	—	—	—	—	—	—
46	—	0.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
47	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

from the length distributions, the recruitment to the stock, as reflected in the number of mackerel measuring from 27 cm to 30 cm, must have been moderate.

Difficulties encountered in the age determinations by means of otolith readings have prevented the computation of reliable age determinations.

J. J. Zijlstra, K. H. Postuma

Tuna

The German Tuna Fishery in 1961

(Figure 1; Tables 3–5)

In 1961, the German tuna fishery was a complete failure. The catch was the lowest since 1951 and amounted to 1,092 fish weighing 286 metric tons (= 305,000 DM) only. As Table 3 shows, nearly 84 per cent of the catches were in Septem-

Table 3 Seasonal catch distribution, average length, weight and feeding coefficient (K)

	Catch in number	Catch in tons	Specimens measured	x in cm	x in k3	K
August	146	39	133	247.010	263.418	1.75
September	918	240	733	246.272	261.657	1.75
October	28	7	26	242.885	262.929	1.83
	1,092	286	892	246.285	261.925	1.75

ber. Similar to other years, this year's first landings were made after the 20. August, thus the fishery terminated 3 weeks earlier than during the previous years, already at the beginning of October, because of the poor results.

From 46 fishing boats participating in the tuna fishing, 27 carried out one fishing trip only, 15 two trips, and 8 three trips. Compared with normal years, up to 5 or 6 trips have usually been made by a number of fishermen. The main fishing took place on the following grounds: Nord-Ost-Bänke, Ost-Bank, Farn Deeps and, at the end of the season, on the Süd-Riff.

Investigations on the catch composition of the North Sea tuna stock were continued at the Institut für Küsten- und Binnenfischerei. In total 892 tuna (= 81% of the total landings) were measured (Table 4).

Table 4. Length distribution (‰) of the German tuna catch in 1961

cm	August	September	October	Total
217.5	2	2	—	2
222.5	11	13	19	12
227.5	36	34	48	34
232.5	70	70	67	69
237.5	121	128	154	127
242.5	187	193	289	195
247.5	201	216	279	216
252.5	162	174	125	171
257.5	116	103	19	103
262.5	54	47	—	47
267.5	17	15	—	15
272.5	13	4	—	6
277.5	8	1	—	2
282.0	2	—	—	1
Number of specimens ...	133	733	26	892
Number of total catch ...	146	918	28	1,092

The following results were obtained:—

1. The average fork length of tuna has furtherly increased and was determined to be 246.285 cm (1960 = 243.105 cm; 1959 = 239.930 cm; 1958 = 232.385 cm).
2. Despite this length increase the average weight of the tuna (gutted fish, but with head and gills) showed a slight decline. It was found to be 262 kg (1960 = 267 kg; 1959 = 254 kg; 1958 = 234 kg). The decrease in weight is partly due to the fact that, in 1960, considerable quantities of October-caught tuna entered the calculation, having normally a much better feeding condition than the September-caught tunas, while only 28 tunas were caught in October 1961. However, another reason for this unexpected decline is the lower feeding coefficient of the September-fish which, with 1.75, was similarly low as in 1957, 1955, and in 1954. It would be interesting to know, if this phenomenon is related to a delay in spawning during these years, as suggested already by TIEWS (1957) (Table 5).
3. By inspection of Figure 1, in which the length frequencies of the tuna catches from 1951 to 1961 are combined, it might be concluded that the North Sea stock of tuna utilized by the German fishermen, in certain periods over serveral years lacks any substantial recruitment. During the 11 years under observation, there are only 2 periods in which substantial recruitment to the stock occurred through immigration of new year-classes. This was once in 1952, when small tunas of 180—200 cm came into the North Sea for the first time, and again during the years 1957 to 1958, when a rejuvenescence of the stock through the immigration of

Table 5. Feeding coefficients of North Sea tuna in various seasons

	1954[1])	1955[1])	1956[2])	1957[2])	1958[2])	1959[3])	1960[4])	1961
August	1.69	1.81	1.78	1.74	1.82	1.81	1.78	1.75
September	1.65	1.74	1.91	1.77	1.84	1.83	1.88	1.75
October	1.72	1.89	1.96	1.84	1.88	1.93	1.90	1.83

[1]) According to TIEWS (1957); [2]) According to LÜHMANN (1959); [3]) According to TIEWS (1961); [4]) According to TIEWS (1962).

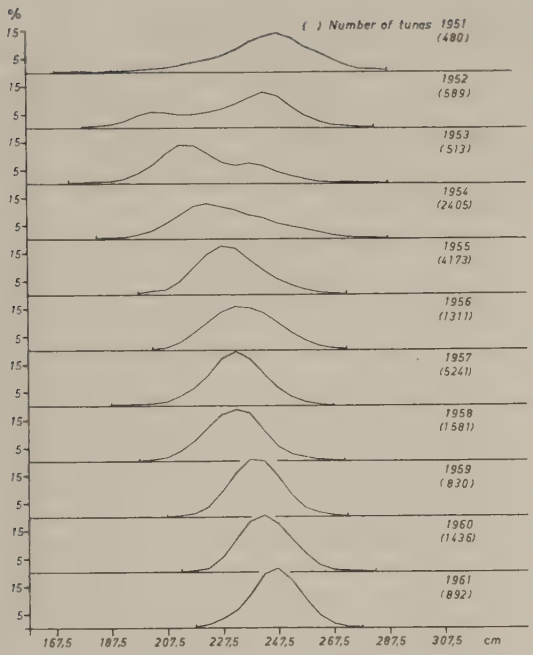

Figure 1. Length composition of the German bluefin tuna catches from 1951 to 1961.

tunas of about 230 cm could be observed. From 1952 to 1956 the German tuna catch was essentially determined by one dominant year-class, about 9 years old (= 190 cm) in 1952 and 13 years (= 240 cm) in 1956.

4. According to the results of length comparisons, it seems to be likely that the recruit year-classes appear at different age for the first time in the central North Sea. While the predominant age-group of the 1952 recruits was about 9 years old, in 1957/1958 it was about 12 years old. This indicates that the different tuna year-classes do not possess the same migration instinct, but reach the different terminal stations of their yearly migration routes at considerably varying ages. Thus, the 1943 year-class which appeared for the first time in the central North Sea in 1952 must be judged as an early arrival, if compared with the year-classes 1945 and 1946, which appeared in full strength for the first time in 1957 and 1958 respectively being then 3 years older than the 1943 year-class had been in 1952.

K. Tiews

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The Norwegian Tuna Investigations, 1961

(Figures 2–3; Tables 6–11)

Migration

On the basis of catch statistics, field observations and tagging experiments described in contributions to *Annales Biologiques* for 1958, 1959 and 1960, it seems likely that the bluefin tuna migrate into the Norwegian Sea west of Shetland and proceed towards the Norwegian coast. The big tuna, being 12 years or more of age migrate to the north coast, the smaller fish migrate southwards along the western coast, to Skagerak and Kattegat. According to Meyer-Waarden and Tiews (1959) the medium sized fish migrate into the North Sea. These immigration routes are shown in Figure 2. The fact that very few tuna are caught in district IV and the northern part of district V during the immigration, indicate that these two routes are separated far out at sea. Attention may also be drawn to the similarity between this migration pattern and the general current system.

The Norwegian tuna fishery is mainly based upon tuna during the immigration. However, at the end of the season a migration has been observed northward along district VI and V, especially of the smallest fish (Hamre, 1961). The schools are reported to be very extensive and are obviously on the point of departing for more southerly latitudes.

Weight frequency distribution

The Norwegian total catch of bluefin tuna in 1961 amounted to 40,261 fish or 6,562,098 kg, i.e. weight of gutted fish. Compared with 1960 it means an increase in the yield of 17,880 fish or 2,317,090 kg. Tables 6—9 show the weight distribution of the tuna landed in districts II—VI respectively. In district VII, 384 tuna were caught but individual weight data have not been available. The collection of the statistical data and the grouping of the material have been made in the same way as for the previous years (Hamre, 1960).

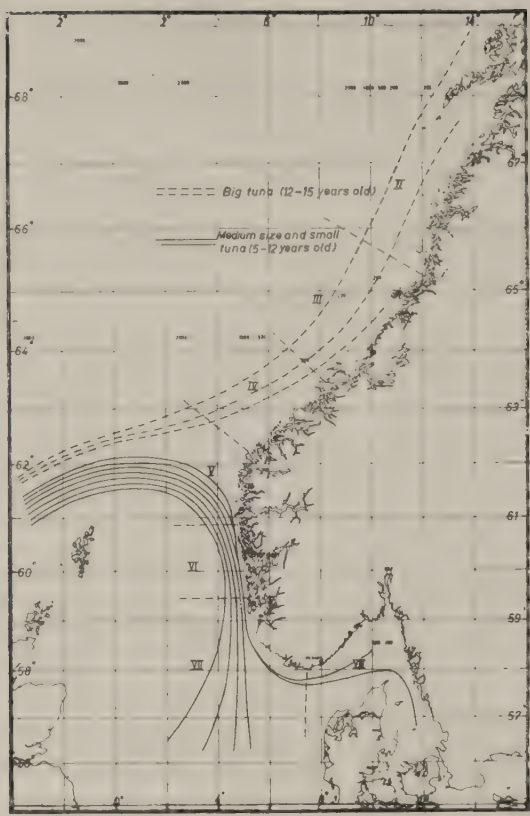

Figure 2. Immigration routes of bluefin tuna to the Norwegian fishing grounds. Numbers II to VIII refer to fishing districts.

In order to facilitate the conversion of weight data to length, corresponding measurements are given in Table 10.

Food conditions

The concentration of food fishes in the vicinity of the Norwegian coast has been considerably greater than for several years.

Tagging experiments

During the 1961 season, 80 tuna were tagged and released in districts V and VI using the same tagging method as in 1959. In 1961, 9 recaptured Norwegian tuna tags were reported (Table 11).

Discussion and results

During the 1961 season there have been at least three runs of tuna to the Norwegian fishing grounds, one to the northern and two to the southern fishing area. The run of tuna to the north occurred in district III in week No. 29 and the fish migrated into district II in week No. 30. In district IV (the transition area) a few catches of tuna were landed during the weeks 28—32. Comparing the weight distribution with that of district III, week No. 29 (Table 7), it seems likely that the schools belong to the northward migrating fish.

The first run to the southern fishing area arrived in week No. 28, a second one in week 33 in the boundary between districts V and VI. The first moved slowly, the second one rapidly towards the south (Table 11, tag No. 6, 7).

From Table 9 it appears that the main part of the second run had passed district VI in week 37. In weeks 39 and 40 the abundance of tuna increased again, and from Tables 8 and 9 it can be seen that the main fishery moved northward. Bearing in mind that the bluefin may gain weight rapidly during the feeding migration, the weight frequency of the catches in week 39 indicate emigrating tuna from the first run, and in week No. 40 fish from the second one. The latter assumption is corroborated by recovery No. 9 (Table 11). However, during weeks 39 and 40, two American tagged tuna were recovered in the boundary between districts V and VI (Mather, 1962), one of them in the same catch as tag No. 9. These fish were tagged off Florida (U.S.A.) at the beginning of June the same year, and demonstrate a trans-Atlantic migration, indicating that an immigration from the other side of the Atlantic may have taken place at the end of the season.

Concerning the migration of the tuna, attention may further be drawn to Table 8, week No. 37. After three weeks with very few observations of fish, great quantities of tuna appear in the northern part of district V. This is the largest fish caught in the southern area during the season, and the schools had a very similar weight composition pattern to that of the tuna which seems to have left district II some weeks earlier (Table 6). After a few days the schools disappeared from the area concerned.

In Figure 3 is shown the weight frequency curves of the tuna landed in the southern and northern fishing areas during the years 1957 to 1961. The columns to the left in the figure illustrate the number of fish caught. From the general appearance of Figure 3, it may be concluded that the 1950 and 1952 year-classes have yielded nearly the whole of the catch in the southern area in 1961. The runs of tuna

Table 6. Weight frequency distribution in *per mille* of Norwegian caught tuna, for district II in 1961; total catch: 8,295 fish

Group mean (kg)	Week numbers 30	31	32	33	34	35	36	Total
67	—	1	—	—	—	—	—	×
72	—	—	—		—	—	—	—
77	—	—	—	—	—	—	—	—
82	—	—	1	—	—	—	—	×
87	1	—	—	—	—	—	—	×
92	1	1	2	—	—	—	—	1
97	—	1	—	—	—	—	—	×
102	4	2	6	2	—	—	—	3
107	3	5	3	2	1	—	—	3
112	2	3	8	7	1	—	—	4
117	5	4	12	2	—	—	—	5
122	4	6	11	4	—	—	—	6
127	9	6	17	2	—	—	—	8
132	11	12	16	9	1	3	—	11
137	17	23	17	13	11	5	59	17
142	29	24	32	28	1	—	—	24
147	33	40	44	34	12	7	—	34
152	40	47	55	44	14	25	—	42
157	43	42	54	70	30	5	59	44
162	55	62	63	78	22	20	—	56
167	68	63	68	70	46	37	—	63
172	58	73	66	69	51	29	—	63
177	74	67	66	57	62	42	59	66
182	64	68	63	64	61	42	177	64
187	69	74	57	85	69	76	—	69
192	77	64	47	75	89	74	—	67
197	64	57	54	37	72	61	—	57
202	65	59	45	45	65	88	118	58
207	54	42	36	47	78	69	59	49
212	43	43	43	51	57	88	59	48
217	35	31	25	23	46	56	118	33
222	17	28	25	22	41	44	177	27
227	24	18	18	15	38	49	—	23
232	13	11	11	16	31	56	—	16
237	7	7	13	13	23	29	—	12
242	2	8	7	7	24	20	—	9
247	4	4	5	4	23	10	—	6
252	3	2	4	3	12	25	59	5
257	1	1	2	—	3	15	—	2
262	1	1	1	2	11	15	—	3
267	—	1	1	2	1	3	—	1
272	—	1	1	—	—	—	—	×
277	—	1	1	2	3	3	59	1
282	—	1	—	—	—	3	—	×
287	—	1	—	—	1	—	—	×
292	—	—	—	—	—	3	—	×
297	—	—	—	—	—	3	—	×
n	1,683	2,194	1,791	684	740	408	17	7,517

× means values between 0 and 0.5.

Table 7. Weight frequency distribution in *per mille* of Norwegian caught tuna, for district III and IV in 1961
Total catch district III: 1998 fish; total catch district IV: 738 fish

Group	District III Week numbers							District IV Week numbers
mean (kg)	29	30	31	32	33	34	Total	28–32
87	—	—	—	—	—	—	—	2
92	—	—	—	5	—	—	1	2
97	—	1	—	2	—	—	1	—
102	—	6	—	—	—	—	3	11
107	—	4	6	7	—	—	4	9
112	—	6	—	—	7	—	4	6
117	5	4	—	12	3	—	5	17
122	—	9	6	5	3	—	6	30
127	10	13	6	9	7	—	10	43
132	5	18	43	5	10	—	14	45
137	15	24	18	46	7	—	24	86
142	21	34	43	32	20	27	31	49
147	56	34	55	35	—	27	33	77
152	26	63	55	46	30	54	50	94
157	36	64	43	85	43	—	59	101
162	56	69	98	71	43	14	65	54
167	103	56	43	74	79	41	66	62
172	92	74	37	81	92	41	76	66
177	82	82	73	71	66	27	75	51
182	77	82	55	67	76	95	76	45
187	62	77	79	46	83	41	69	34
192	92	76	43	62	56	95	70	41
197	51	48	61	67	69	81	58	26
202	41	46	31	48	43	54	45	6
207	51	28	43	37	26	54	34	9
212	31	29	31	23	56	81	34	15
217	36	13	37	18	40	68	25	6
222	26	16	18	9	40	41	20	9
227	5	5	12	9	20	68	11	—
232	15	9	6	2	26	41	12	2
237	5	5	12	7	13	14	8	—
242	—	2	12	7	13	27	7	—
247	—	—	6	2	3	—	2	2
252	—	—	6	—	7	—	2	—
257	—	2	12	9	7	—	5	—
262	—	1	6	2	10	—	3	—
267	—	—	6	—	3	14	2	—
n	195	827	164	435	303	74	1,998	467

Table 8. Weight frequency distribution in *per mille* of Norwegian caught tuna, for district V in 1961; total catch: 9,612 fish

Group mean (kg)	Week numbers 28	29	30	31	32	33	34	35	36	37	38	39	40	Total
57	—	—	—	—	—	—	—	11	—	—	—	—	—	×
62	—	—	—	—	—	—	—	4	—	2	—	—	—	×
67	—	—	—	—	—	—	—	—	—	1	—	—	—	×
72	1	—	—	2	—	—	9	—	—	1	—	—	—	×
77	—	—	—	—	—	—	—	—	—	2	—	—	—	×
82	1	1	3	—	3	—	—	15	5	1	—	—	—	1
87	1	—	—	2	3	4	9	19	5	2	5	—	—	2
92	5	4	2	2	12	8	—	49	5	7	5	10	1	7
97	7	3	10	11	12	8	—	57	21	5	10	6	3	8
102	10	7	21	11	22	15	—	72	21	7	15	12	1	13
107	7	11	9	18	22	32	—	91	52	12	20	20	4	17
112	14	9	27	13	31	33	—	49	26	15	25	25	3	19
117	17	17	32	18	28	31	35	57	42	12	35	23	11	22
122	29	22	40	29	46	34	9	65	52	14	15	20	9	26
127	45	48	40	29	43	48	35	65	73	18	35	18	16	36
132	73	44	46	47	61	41	18	61	52	15	25	6	16	40
137	83	61	67	54	83	61	44	38	73	19	35	23	22	52
142	81	91	90	81	86	67	97	61	47	23	40	29	26	62
247	98	95	94	89	64	64	89	80	83	28	40	35	39	68
152	99	107	75	119	107	78	62	30	67	32	55	49	42	73
157	80	104	90	87	83	71	80	15	42	41	95	49	54	70
162	64	73	72	85	49	74	44	46	42	53	50	80	69	65
167	66	66	59	81	61	50	27	23	62	53	80	74	64	60
172	57	51	55	71	58	52	71	27	36	65	75	68	76	59
177	55	55	30	45	28	44	106	23	57	59	65	76	70	52
182	27	35	42	38	15	35	18	15	16	57	65	59	77	42
187	18	28	25	11	37	27	44	11	21	57	50	47	74	35
192	19	21	25	20	25	27	35	—	21	55	50	59	59	33
197	14	16	12	16	9	24	44	—	26	46	20	45	63	27
202	21	14	13	9	—	18	35	8	5	48	25	43	40	25
207	4	6	9	2	—	14	35	—	10	37	10	27	34	16
212	2	5	6	2	9	10	18	—	—	37	20	20	30	14
217	2	4	1	4	—	5	27	4	10	30	—	14	29	11
222	1	2	3	—	—	5	—	4	5	31	—	14	16	10
227	2	1	—	4	—	6	—	—	10	29	5	16	9	9
232	1	—	1	2	—	7	—	—	5	26	—	6	16	8
237	—	—	1	—	3	3	—	—	10	14	10	2	10	5
242	—	—	—	—	—	2	9	—	—	15	15	6	7	4
247	—	2	—	—	—	2	—	—	—	9	—	12	1	3
252	—	—	—	—	—	2	—	—	—	7	5	4	1	2
257	—	—	—	—	—	—	—	—	—	5	—	—	1	1
262	—	—	—	—	—	1	—	—	—	4	—	—	1	1
267	—	—	—	—	—	—	—	—	—	1	5	—	3	1
272	—	—	—	—	—	—	—	—	—	3	—	2	—	1
277	—	—	—	—	—	—	—	—	—	1	—	—	3	×
282	—	—	—	—	—	—	—	—	—	2	—	—	—	×
287	—	—	—	—	—	—	—	—	—	1	—	—	—	×
292	—	—	—	—	—	1	—	—	—	—	—	—	—	×
n	1,679	1,053	975	553	326	1,186	113	263	193	1,882	201	489	699	9,612

Table 9. Weight frequency distribution in *per mille* of Norwegian caught tuna, for district VI in 1961: total catch: 19,234 fish

Group mean (kg)	Week numbers 28	29	30	31	32	33	34	35	36	37	38	39	40	41	Total
62	—	—	1	—	—	—	—	—	—	—	—	—	2		×
67	—	—	—	—	1	—	—	—	—			—	1		×
72	—	—	—	—	1	—	2	1	—	—	—	—	—	—	×
77	—	—	1	—	2	—	1	1		—		—	—		4
82	—	—	—	1	—	2	1	3	2	19	—	—	1	—	1
87	1	—	1	4	1	1	2	7	3	10	—	—	1	—	2
92	4	2	7	4	5	6	13	17	6	19	—	2	4	—	7
97	3	5	13	5	5	17	19	25	10	57	—	2	8	—	12
102	5	6	23	22	14	26	30	35	29	38	—	3	18	—	20
107	7	8	23	26	27	27	47	41	40	48	—	8	26	18	24
112	6	12	20	23	25	34	39	50	40	57	41	8	32	53	27
117	13	12	16	27	19	42	62	55	51	67	—	18	38	70	31
122	25	15	32	33	29	35	41	43	48	48	41	6	32	—	31
127	34	26	39	45	32	42	52	47	38	86	—	17	36	35	38
132	41	36	53	49	49	47	47	45	43	48	—	21	26	35	43
137	58	52	63	63	49	62	42	52	46	19	41	24	42	53	53
142	74	69	78	71	57	75	60	59	54	57	41	36	50	105	66
147	88	74	78	80	75	73	79	58	56	38	61	57	42	88	70
152	94	91	76	96	92	68	66	56	41	76	122	59	44	53	75
157	90	79	77	76	80	68	63	58	67	57	41	51	69	53	72
162	83	81	74	73	82	58	45	55	48	29	41	68	55	105	67
167	77	69	68	50	66	61	40	56	40	29	41	66	47	53	60
172	63	80	52	60	65	54	40	43	57	48	102	87	46	35	59
177	44	56	41	38	51	38	39	38	46	38	82	74	63	35	46
182	52	51	39	44	43	39	33	36	45	19	—	71	47	18	44
187	36	40	28	29	38	27	20	22	38	10	20	60	55	—	33
192	24	40	22	20	27	21	24	17	25	10	61	35	40	35	26
197	25	22	23	17	18	15	24	15	18	10	41	42	39	105	22
202	19	17	15	13	15	15	14	17	25	10	61	36	37	—	18
207	10	20	12	14	8	14	17	13	21	19	20	30	21	18	15
212	7	9	7	4	7	9	15	9	14	38	—	26	14	18	9
217	4	7	5	3	4	7	6	8	10	—	—	15	17	—	7
222	5	8	4	4	4	5	3	5	6	—	41	18	15	—	6
227	3	4	6	3	1	5	3	4	6	—	20	17	13	—	5
232	1	4	2	1	3	3	1	2	10	—	—	17	4	18	3
237	1	2	2	1	2	1	3	3	6	—	20	11	5	—	3
242	1	2	1	1	—	2	3	2	5	—	—	6	7	—	2
247	1	1	1	1	1	1	1	—	—	—	61	5	1	—	1
252	1	—	1	—	1	—	—	1	5	—	—	—	3	—	1
257	—	—	—	—	—	—	1	1	3	—	—	2	—	—	×
262	—	—	—	—	—	—	—	—	—	—	—	3	1	—	×
267	—	—	—	—	—	—	1	—	—			3	1	—	×
n	1,639	3,387	2,092	1,839	959	2,243	970	3,132	629	105	49	664	1,080	57	18,845

Table 11. Release and recovery data for Norwegian tagged bluefin tuna

No.	Release Date	Release Locality N	Release Locality E	Recapture Date	Recapture Locality N	Recapture Locality E	Days at liberty	Weight in kg (w)
1	Sept. 8. 1959	59°44′,	5°00′	Aug. 5. 1961	60°43′,	4°35′	697	163
2	Aug. 8. 1960	60°44′,	4°29′	July 31. 1961	60°51′,	4°35′	358	163
3	Aug. 8. 1960	60°44′,	4°29′	Aug. 28. 1961	60°18′,	4°49′	385	180
4	Aug. 9. 1960	60°30′,	4°42′	Aug. 3. 1961	66°15′,	10°30′	359	224
5	Aug. 25. 1960	60°24′,	4°50′	Aug. 18. 1961	61°03′,	4°25′	358	136
6	Aug. 16. 1961	60°44′,	4°40′	Aug. 30. 1961	59°41′,	5°00′	14	198
7	Aug. 21. 1961	60°44′,	4°38′	Aug. 28. 1961	60°08′,	4°58′	7	180
8	Aug. 28. 1961	60°15′,	4°50′	Oct. 6. 1961	60°50′,	4°40′	39	146
9	Sept. 3. 1959	60°15′,	4°45′	Sept. 30. 1961	60°40′,	4°40′	758	—

Table 10. Average length, weight, and condition factor $K = 10^5 \frac{w}{\bar{l}^3}$ of tuna landed to district VI in 1961

Week No.	n	w'	$\bar{w}$	$\bar{l}$	K
30	25	157	203	220	1.91
31	22	164	211	221	1.95
33	25	162	208	222	1.90
36	25	187	241	231	1.96

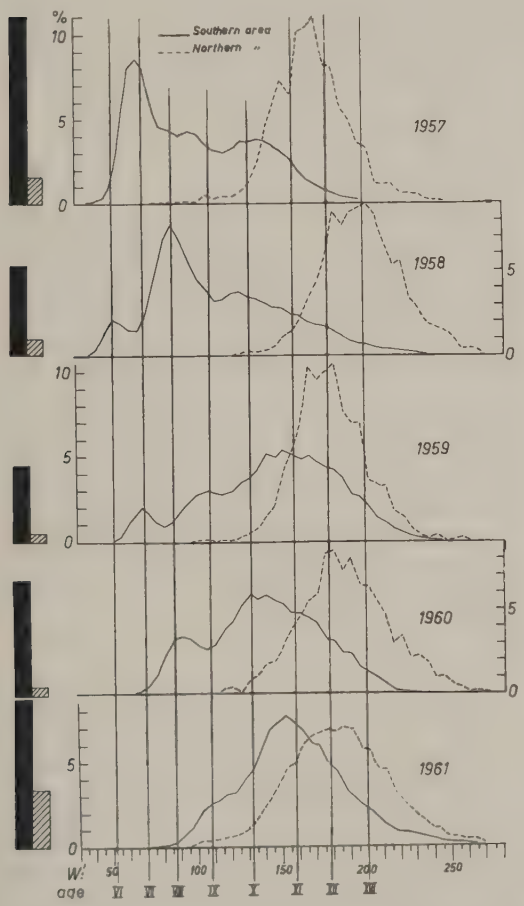

Figure 3. Weight composition (w' = commercial weight in kg) of Norwegian tuna landings by fishing areas. The shaded columns illustrate number of fish caught in the northern area (districts I to III), the black columns number of fish caught in the southern area (districts V to VIII). One unit = 3,000 fish.

dominated by the 1950 year-class have previously been mixed with tuna from the 1949 year-class, even dominating in 1955 (Hamre, 1960), but the relative strength of these big fish is now considerably reduced.

Regarding the northern fishing area, the weight distribution and the increase in catch clearly demonstrate a recruitment to the stock in 1961 of 12 year-old fish mainly. Moreover, a tuna tagged in the southern area in 1960 was recaught in the northern area this season (Table 11, tag No. 4). From these facts it may be concluded that the main part of the 1949 year-class has changed to the northerly migration pattern at the age of 12 years, in good accordance with the prognosis released before the 1961 season started (broadcast June 1961).

As there is no recruitment of younger age-groups to the southern fishing area, it might be expected that the loss of the 1949 year-class would lead to a decrease in the catch landed in the area concerned. However, the fishery has yielded about 9,000 fish more than last year. One reason for this good result is the early arrival of the tuna this year. An additional cause is that the great concentration of food fishes in the vicinity of the coast has no doubt favoured the tuna fishery on the Norwegian coast in 1961.

From Figure 3 it seems likely that the increase in yield of the northern fishing area in relation to that of the southern will continue in the next years. The main part of the tuna from the very strong 1950 year-class may already migrate to the north of Norway in 1962. This may lead to a radical regional change in the Norwegian tuna fishery.

J. Hamre

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Salmon and Trout

England and Wales

Salmon and Sea Trout Research 1961

The River Axe (Devon) investigations

1. *Salmon.* The counting trap fished continuously in 1961 except for one day in April and five in December when exceptional floods prevented operation.

During the year, 374 salmon entered the river and of these approximately half ran in the last 3 months of the year. 37 were caught by net or angling before reaching the trap and subsequent losses from angling and other mortalities left a spawning escapement of 280 fish.

The 1959 spawning run, of which 160 had been tagged as kelts passing back to the sea, was represented by 5 fresh-run fish in 1961 (making a total of 9 returning spawners of this year-class so far). The 1960 spawning run, of which 308 had been tagged as kelts was represented by 6 female fish arriving at the trap. Another was caught by net in the River Teign Estuary, west of the River Axe.

In the spring of 1961, 6,151 salmon smolts were trapped. Of these 5,152 were tagged with English silver platelet tags and 999 with Scottish telcothene sleeve tags, as part of the international tagging trials. The 1960 Axe tagging trials between Norwegian, Swedish and English tags have so far provided four returns, three of which (1 Swedish, 2 English) reentered the River Axe, and one (Swedish) was caught in the Bay of Concarneau, Brittany.

2. *Sea Trout.* From the 1960 spawning run of 1,380 sea trout over 40 cm in length (i.e., excluding .0 + fish) 732 kelts were trapped and tagged, mainly in December and January. Of these kelts, 254 have since been recaptured mainly in the River Axe but some in other rivers to the west of the Axe and on the coast to the eastward. One was caught 200 miles east, on the Kentish coast, 36 days after release.

Sea trout smolts began to migrate on 24. February, when large specimens appeared. 900 were tagged with Carlin tags, and 4,472 with English tags; both types were put on without anaesthetics. Recaptures so far are 7.9% for the Carlin and 10.4% for the English tags. Of these smolts, 536 either returned to the Axe as .0+ fish during the year, or were caught in nearby rivers or on the coast; one was taken in the East Looe River, Cornwall. In 1961, 3,126 sea trout were counted up the river; a third of these were .1+ or older fish, and the remainder, .0+ fish.

Rivers Usk, Wye and Severn experiment

The salmon homing experiment was continued in 1961; 4,014 salmon smolts were tagged at Brockhampton on the Wye, and on the Severn 897 smolts were tagged at Tewkesbury and 1,606 at Gloucester, giving a total of 2,503 for the river. Netting in the River Usk produced only 17 smolts, but 589 were tagged after rescue from the cooling water intake of the Uskmouth Power Station which is on the estuary near its mouth, making 606 for the river.

Six recaptures have been reported during the year: —

Year of tagging	Place	Position of recapture
1958	Gloucester	R. Teme (tributary of Severn)
1959	Tewkesbury	Wellhouse Bay (Severn Estuary)
1959	Brockhampton	Chepstow (R. Wye Estuary)
1959	Uskmouth	Goldcliff (just outside Usk Estuary)
1960	Brockhampton	Chepstow (R. Wye Estuary)
1960	Uskmouth	Kangamiut, West Greenland (65° 50′N. 53° 21′W)

In addition, 14 tagged smolts were recovered from the cooling water system of Berkeley Power Station, on the East bank of the Severn Estuary between Gloucester and the point where the Wye enters. Nine of the smolts were from the Severn (five from Gloucester, four from Tewkesbury), and five from the Wye. This indicates that the Wye smolts move up the Severn Estuary as well as down it on their way to the sea.

W. G. Hartley

German Salmon Fishery in the Baltic in 1961

(Tables 1–3)

The yield of the German salmon fishery in the south-eastern part of the Baltic rose from 217 tons in 1960 to 345 tons in 1961. Therewith the landings reached the same height as in 1957, which was the best fishing year up to the present. This remarkable increase was caused by good catches in the first months of the year as well as in the last months, belonging to two different fishing seasons, as the fishery is stopped during 3—4 months in the summer.

The fishing season 1960/61 ending in the first days of May, resulted in a total catch of 282 tons, i.e. 113 tons more than in the previous season, 1959/60. Thus the regular shift between higher and lower salmon catches continued, owing to a rich smolt year-class which became fishable as A.2 years old fish in the autumn of 1960. According to the

Table 1. Monthly landings of salmon in 1961 compared with the average of 1955/60

Month	1961 Tons	1961 %	1955/60 Tons	1955/60 %
January	50.7	*14.7*	35.7	*14.9*
February	52.4	*15.2*	19.3	*7.7*
March	20.4	*5.9*	31.9	*13.3*
April	20.7	*6.0*	19.4	*8.1*
May	3.5	*1.0*	14.4	*6.0*
September	3.6	*1.0*	0.5	*0.2*
October	25.8	*7.5*	9.4	*3.9*
November	73.7	*21.3*	49.4	*20.7*
December	94.4	*37.4*	60.5	*25.0*
Total	345.2	*100.0*	240.5	*100.0*

scale reading by Fr. Thurow, the catches in January 1961 consisted of 49.0% age-group 3.2 and 18.6% age-group 2.2, those being the most frequent age-groups. In spite of the high percentage of the 1959 smolt year-class (77%), the average weight of the salmon caught was relatively high, 5.09 kg, owing to the excellent growth of this year-class. The mean catch per trip amounted to 640 kg, an increase of 43% compared with that of 1959/60, whereas the total catch increased by 67% due to more intensive fishing (abt. 440 trips).

The present fishing season 1961/62 promises a further rise in the landings, instead of the expected decrease in accordance with the regular changes of rich and poor catches. The salmon fishery by nets began in late August already, but the main catches by drift lines were landed from October onwards. Up to December 1961 the landings amounted to 197.5 tons, i.e. 63 tons more than in the same months of the previous years and even more than in the record season 1956/57 (188 tons). The 1960 smolt year-class surprisingly proved to be abundant, probably more frequent than the preceding rich 1959 smolt year-class. Owing to the high proportion of A.2 year-old salmon (more than 80%) and their lower growth, the mean weight decreased remarkably from 5.09 kg in 1960/61 to 3.97 kg in October/December 1961. The mean catch per trip was 843 kg which quantity was reached or surpassed in some months of the fishing seasons 1958/59 and 1956/57 only.

The size composition of the landings at the Kiel Fish Market in 1961 is given in Table 2.

Table 2. Size composition of salmon landed at the Kiel Fish Market in 1961

Market category gutted weight, kg	I < 8	II 7–8	III 5–7	IV 3–5	V 2–3	VI 1–2	Average weight, kg
	Number %						
Jan./Feb.	10.7	8.2	24.5	53.1	3.4	0.1	5.15
March/Apr.	11.3	8.6	24.8	52.0	3.1	0.2	5.22
May	3.8	3.2	20.3	64.6	8.1	—	4.42
Sept./Oct. .	4.8	3.3	8.3	59.8	22.9	0.9	3.93
Nov./Dec. .	6.2	3.5	8.9	55.7	23.0	2.7	3.99
Total catch	7.9	5.4	15.3	55.0	14.9	1.5	4.46

The figures in Table 2 illustrate the changes of the size composition and the average weight of salmon during the year owing to spawning migration of older fish and the appearance of an abundant new year-class in the fishable stock, apart from the growth. The percentage of larger salmon (> 5 kg) heavily decreased, whereas the quantity of small fish (< 3 kg) increased to the same extent. Only the proportion of medium-sized fish (3—5 kg) remained nearly constant.

To complete the survey given in the report for 1959 (Ann. Biol., **16**, p. 251), the quantity of each market category landed at the Kiel Fish Market during the two last years is given in Table 3.

Table 3. Salmon landed at the Kiel Fish Market in 1960 and 1961 (in tons)

Market category	I	II	III	IV	V	VI	Total
Jan./June 1960	19.8	8.9	8.0	24.6	6.5	0.4	68.2
Sept./Dec. 1960	16.4	9.2	27.6	42.3	2.4	0.1	98.0
Jan./May 1961	23.4	14.4	33.2	51.6	2.1	0.1	124.8
Sept./Dec. 1961	18.9	8.8	17.3	71.4	19.9	1.4	137.7

For nearly all market categories the landings in 1961 surpassed those in 1960, in the winter/spring as well as in the autumn. The increase is largest for the market categories IV and V in the autumn catches, indicating the abundance of the 1960 smolt year-class.

Thus the detailed analyses of statistical, data carefully collected throughout the year, give a reliable insight in the changes of the size composition and fluctuations of the salmon stock in the Baltic.

R. Kändler

Shellfish

CRUSTACEA

Tagging Experiments on *Cancer pagurus* in Norwegian Waters

(Figures 1–6)

The "suture tag" method, originally devised by VAN ENGEL, was in Norway for the first time tried on *Cancer pagurus* during the autumn of 1959. As this method appeared to be time-consuming and moreover rather difficult, another method has been developed. In this new method a double tag is used, one applied internally, one externally. The internal tag is made of plastic or stainless steel; the dimensions are: length 14 mm, breadth 3 mm, thickness 0.5 mm. In addition to letter and number stamped on the tag, a small hole, 0.8 mm in diameter, has been pierced in the middle of the flat side. The external tag is made of plastic and has the same shape as the internal tag but is somewhat larger: 20 × 4 × 0.5 mm and the hole has been made at the end on the flat side. A piece of nylon gut No. 30, a knot having been made at one end, is pulled through the hole in the internal tag, until it is stopped by the tag. The external tag is then tied to the other end of the nylon gut (Fig. 1).

The tagging operation is carried out as follows: with an awl a small hole is made in the ventral

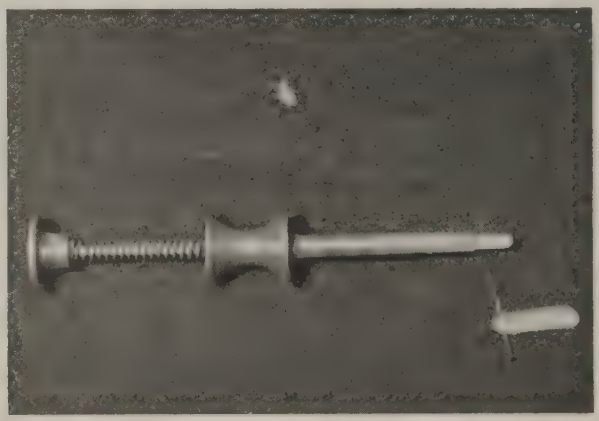

Figure 1. Internal tag in the pump, external tag outside

Figure 2. The hole is made with an awl.

Figure 3. The internal tag is pumped in.

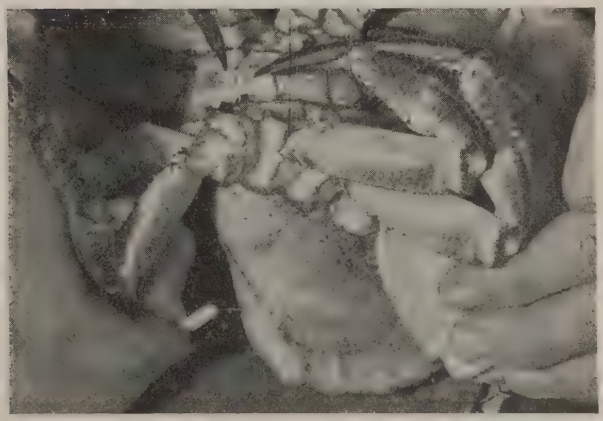

Figure 4. The internal tag is moved to its right place.

side of the carapace, on the line of separation at moulting (Fig. 2). The hole is T-shaped and just big enough to let the small tag pass. By means of a specially made pump the small tag is inserted into the crab with the right hand, while the left hand holds the bigger tag (Fig. 3). By pulling carefully at the external tag when the internal tag has passed carapace and skin, the internal tag will slide backwards inside the body of the crab until the hole in the tag is just opposite the hole in the carapace (Fig. 4). In reality this is the same method as used in sleeve-buttoning.

Crabs tagged in the autumn of 1959 by both the "suture" method of Van Engel and the new method mentioned above, were recaptured during 1961. There was a great difference in results between the two methods. The wound in the carapace was very big in crab tagged with the suture method and it looked as if the stainless steel wire had been cutting along the line of separation of the carapace during ecdysis (Fig. 5). Some of the captured crabs wore visible signs of having been tagged. Obviously the tag had been shed because the stainless steel wire had cut along the line of separation.

Recaptured crabs tagged with the new method presented quite a different picture. Crabs which had moulted after tagging, revealed a wound smaller than it must have been immediately after the tagging operation. This made the impression that the wound in the carapace had healed towards its centre (Fig. 6). Inside the shell the internal tag appeared to be quite coalesced with the flesh and it did not seem to harm the crab at all.

During the year 1959, 83 crabs were tagged at

Figure 6. The new method. Crab tagged on 24. November 1959 and recaptured on 29. September 1961. The crab has moulted and increased 30 mm in breadth.

Figure 5. The "suture" method. Crab tagged on 10. November 1959 and recaptured on 20. August 1961. The crab has moulted and increased 15 mm in breadth .

Nordnespynten, Bergen Harbour; 3 of these were recaptured the same year, and 2 in 1961. The latter two had moulted, and the increment in breadth was 15 mm and 30 mm respectively.

In the period 14. October to 15. December 1960, 70 crabs were tagged at Nordnespynten, a further 122 in the Hjeltefjord area. This batch gave 6 recaptures in the same year and 7 during 1961. One of these crabs had moulted and had increased 30 mm in breadth.

During 1961, 504 crabs have been tagged in the Hjeltefjord area and 322 at Nordnespynten. 35 were recaptured the same year. In 1961 the new tagging method was used exclusively.

KAARE R. GUNDERSEN

MOLLUSCA

Nutrition, Chemical Composition, and Possibilities for Utilization of the Sea Mussel, *Mytilus edulis* L., from the Southern Baltic

(Figure 7; Table 1)

Investigations on nutrition, chemical composition and possibilities for utilization of the sea mussel, *Mytilus edulis* L., from the southern Baltic Sea were carried out in the years 1959—1961. The investigations on nutrition in the sea mussel revealed that the main elements of its food are Bacillariophyceae and Chlorophyceae. The dominant species found in the alimentary tract were the same as those dominating in the plankton at the same time. The data obtained can be used to study whether the kind of food taken up by the mussel exerts an influence on the chemical composition of its edible parts, this in relation to the seasons. Seasonal variations in the main chemical components (proteins, fat, carbohydrates) were apparent, this both in the whole organism, and in the edible parts. The variations in the chemical composition of the edible parts seem to be associated with the kind of food found in the alimentary tract (Figure 7). Food rich in proteins and fat (Bacillariophyceae) seems to lead to accumulation of these components in the organism; uptake of a food rich in carbohydrates (Chlorophyceae) was followed by an increment in the carbohydrate content of the edible part of the mussel.

In the summer season an increment in the percentage of organic material could be observed in the edible part of the mussel. On the other hand, a decline in the percentage of the organic material could be observed in the winter season. These seasonal changes are predominantly brought about by variations in the contents of carbohydrates. Variations in the protein content of the edible parts seem to be inversely proportional to changes in the carbohydrate content. The fluctuations in the carbohydrate content are, however, considerably greater and inevitably lead to inverse fluctuations in the protein percentage. The fluctuations in the ash percentage of the edible parts run parallel to the changes in the protein content.

It is reasonable to suppose that it is the spawning of the sea mussel which leads to the remarkable decline in protein and fat percentages in the summer season.

The Baltic sea mussel, being of a small size, (shell length up to 5 cm) is not used as human food.

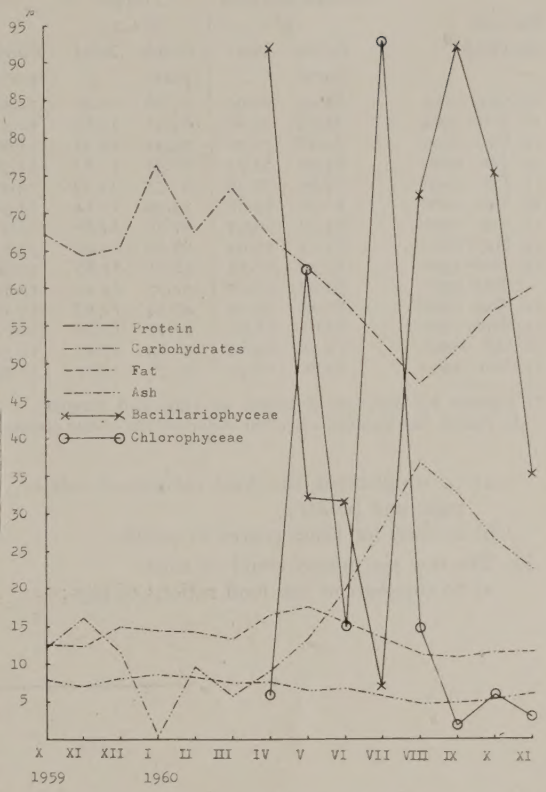

Figure 7. Relations between the kind of food and the chemical composition of the edible parts of the sea mussel, *Mytilus edulis*.

But their abundance in the southern Baltic invites utilization for other purposes. It has been considered whether the sea mussel could be used in the raw state, or as a dry meal of the whole organism. Chemical analysis indicate which season would be the best for harvesting this resource (Table 1). It seems advisable to collect the mussels in the period from April to November, i.e. at the time one could produce a meal with the highest content in valuable constituents such as proteins, fat, and carbohydrates.

The author sees the following possibilities to utilize the sea mussel: —

I. A dry meal made from sea mussels could be used:

Table 1. Fluctuations over the period 1959/1960 in the chemical composition of meal and the edible parts of the sea mussel, *Mytilus edulis*

Date of sampling	% water in the raw material of		Percentage of dry matter									
			Protein N 6.25		Fat		Carbo-hydrates		Organic matter		Ash	
	Edible parts	Meal	Edible parts	Meal	Edible parts	Meal	Edible parts	Meal	Edible parts	Meal	Edible parts	Meal
16. Oct. 1959 ...	84.05	70.90	67.26	12.90	12.54	1.30	12.27	3.62	92.07	17.82	7.93	82.18
16. Nov. 1959 ..	83.75	70.60	64.41	12.80	12.34	1.60	16.16	3.32	92.91	17.72	7.09	82.28
14. Dec. 1959 ..	83.28	71.00	65.34	12.55	14.99	1.68	11.53	3.26	91.86	17.49	8.14	82.51
15. Jan. 1960 ..	84.06	72.75	76.58	11.85	14.58	1.71	0.21	2.47	91.37	16.03	8.63	83.97
12. Feb. 1960 ..	84.89	73.10	67.75	11.72	14.33	1.45	9.61	2.77	91.69	15.94	6.31	84.06
16. Mar. 1960 ..	86.78	73.82	73.39	12.14	13.34	1.32	5.76	2.42	92.49	15.88	7.51	84.12
17. Apr. 1960 ..	83.52	69.94	66.70	*14.80*	16.47	*2.54*	9.09	3.38	92.26	*20.72*	7.74	79.28
14. May 1960 ..	83.74	71.63	62.70	*14.42*	17.55	**2.90**	13.36	*4.51*	93.61	*21.83*	6.39	78.17
13. June 1960 ..	82.74	70.73	58.01	**14.83**	15.39	*2.81*	19.78	*5.61*	93.18	**23.25**	6.82	76.75
July 1960 ..	81.98	70.75	52.57	*14.44*	13.34	*2.28*	28.28	*5.96*	94.20	*22.68*	5.80	77.31*
12. Aug. 1960 ..	81.23	70.79	47.14	*14.05*	11.29	*1.75*	36.79	*6.32*	95.22	*22.12*	4.78	77.88
13. Sept. 1960 ..	80.67	68.90	51.71	*13.78*	10.77	*1.72*	32.61	**7.36**	95.09	*22.86*	4.91	77.14
12. Oct. 1960 ...	79.51	69.82	56.83	*14.21*	11.54	*2.05*	26.42	*6.66*	94.79	*22.92*	5.21	77.08
14. Nov. 1960 ..	79.80	68.29	59.71	*13.74*	11.57	1.42	22.67	*5.49*	93.95	*20.65*	6.05	79.35

*) Figures for July are averages of June and August.
In italics, the months when the composition of the chemical components is best for exploitation.

a) to supplement the food rations of cattle, pigs, and poultry;
b) as food for fishes reared in ponds.

II. The raw sea mussel could be used:
a) to supplement the food rations of pigs;
b) as food for trout in pond rearing, after carrying out some preliminary experiments to investigate the value of this food for trout rearing.

IDZI DRZYCIMSKI